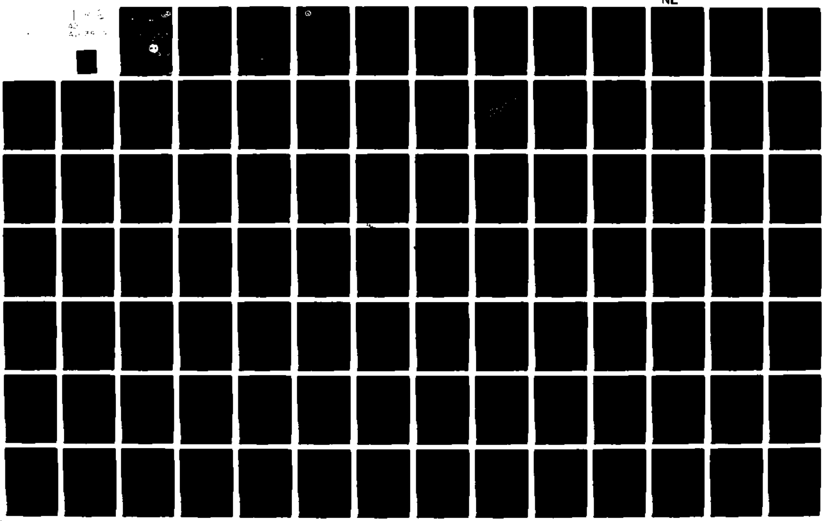
AD-A103 889 DEFENSE COMMUNICATIONS AGENCY ARLINGTON VA F/G 17/2
INTEGRATED AUTODIN SYSTEM ARCHITECTURE REPORT. PART 2.(U)
MAR 79

UNCLASSIFIED NL



LEVEL III

(2)

DEFENSE COMMUNICATIONS AGENCY

INTEGRATED AUTODIN SYSTEM ARCHITECTURE REPORT

(PART 2)

Prepared by: DCA/CODE 403A   MARCH 1979

DISTRIBUTION "A": APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER
IASA Report, Part 2

2. GOVT ACCESSION NO.
AD-A103889

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
INTEGRATED AUTODIN SYSTEMS ARCHITECTURE REPORT. Part 2

5. TYPE OF REPORT & PERIOD COVERED
Final

6. PERFORMING ORG. REPORT NUMBER
IASA Report (Part 2)

7. AUTHOR(s)
DCA Code 403A (now DCA Code 262)

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Defense Communications Agency, Code 262
8th & South Courthouse Road
Washington, D. C. 20305

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
1007

11. CONTROLLING OFFICE NAME AND ADDRESS
same

12. REPORT DATE
Mar[illegible]979

13. NUMBER OF PAGES
180

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)
Same

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Distribution A. Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)
Same

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
AUTOMATIC DIGITAL NETWORK (AUTODIN)
Packet Switch Node (PSN)
AUTODIN Switching Center (ASC)
Integrated Autodin Systems Architecture (IASA)
AUTOMATED MESSAGE PROCESSING EXCHANGE (AMPE)
Inter-Service/Agency AMPE (I-S/A AMPE)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report identifies three alternative architectures for the IAS mid-term (1984-1988), and describes the process and rationale for selecting the preferred (Alternative II) architecture. The preferred architecture represents a distributed architecture where services are provided from a common access are element. The major elements of the architecture are the AUTODIN II PSNs, the Inter-Service/Agency (I-S/A) AMPEs and subscriber terminals. This report identifies the roles and relationships of these mid-term IAS elements, identifies the I-S/A AMPE as the replacement (continued)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. for today's AUTODIN I switching centers and the current Service/Agency AMPEs, and recommends an architectural structure which modes switching functions closer to the user. This approach will reduce the dependency on the more vulnerable backbone switches and should enhance overall survivability.

Based upon the evaluation criteria of operational effectiveness, flexibility survivability/availability, transition, and cost, the preferred mid-term architecture: (1) satisifies all of the identified services/functions; (2) offers significant cost reduction through standardization; (3) provides improved access reliability; (4) permits improved speed of service; (5) provides flexibility in satisfying user unique requirements; (6) can be implemented in an evolutionary process; and (7) provides the framework for continued development through 1988 and beyond

B

DEFENSE COMMUNICATIONS AGENCY
WASHINGTON, D.C. 20305

USERS GUIDE TO THE INTEGRATED AUTODIN SYSTEMS ARCHITECTURE (IASA) REPORT, PART 2

1. General. This is the second in a series of three Integrated AUTODIN Systems Architecture (IASA) Reports, addressing the architectural alternatives for the Integrated AUTODIN System from the present to 1990.

2. Applicability. The user is cautioned in the use of this report. It updates much of the IASA Report, Part 1; similarly, the Part 2 report is to be further updated by the IASA Report, Part 3 (now in review). Nearly all of the milestones, manning data, deployment figures and schedules have changed as a result of the maturing systems architecture approach.

3. Approval. The IASA Report, Part 2, dated March 1979 was approved by the Assistant Secretary of Defense, Command, Control, Communications , and Intelligence (ASD/C3I) on 9 June 1980. This approval incorporated the architectural decisions made since the report was issued. In summary, this approval acknowledged a target date of FY 1985 for the I-S/A AMPE Initial Operational Capability (IOC). It directed the procurement of an accredited DSSCS/GENSER I-S/A AMPE using new hardware and new design of applications software using an approved high order programming language. This I-S/A AMPE will be a functional replacement for the AUTODIN I Switching Centers (ASC). and will provide an interface for the AUTODIN I community of terminals to the AUTODIN II system.

4. Definition Changes. In the IASA Report, Part 2, Architecture Alternative II was selected as being the most cost effective approach for I-S/A AMPE implementation. For clarity throughout the IASA Report, Part 2, the term "I-S/A AMPE(E)" should be replaced by the term "I-S/A AMPE". "AMPE" is the term applied to existing Service/Agency AMPEs (i.e., LDMX (NAVY); AMME (ARMY); AFAMPE(USAF); STREAMLINER(NSA).

5. Architecture. The nodal functions of the existing AUTODIN Switching Centers (ASCs) have been combined with AMPE functions to provide a network access element now designated the I-S/A AMPE. The AUTODIN I ASCs will be phased out by "phasing in" three or more I-S/A AMPEs on a regional basis to service the AUTODIN I subscribers then connected to the ASC. The IAS architecture provides for a Common Family of Network Elements (CFNE) which includes the I-S/A AMPE, the DoD AUTODIN Subscriber Terminal (DAST) family, the DoD Standard Network Front End (SNFE), and AUTODIN Switches, among other IAS element configurations.

6. Availability of Report. This report has been placed in the Defense Technical Information Center (DTIC) and may be ordered under AD- . The DTIC, formerly the Defense Documentation Center (DDC), is located at Cameron Station, Alexandria, VA 20315.

7. Point of Contact. For further information on the applicability and content of the IASA reports, the point of contact is Mr. C. I. Eisiminger, Network Access Systems Branch, DCA Code 262, 8th & So. Courthouse Road, Washington, D.C. 20305. Phone (202) 692-5127/5129. AUTOVON 222-5127/5129.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The purpose of this report is to identify mid-term, 1984-1988, Automatic Digital Network (AUTODIN) architecture alternatives and recommendations to meet user needs for common-user record and data communications. It provides the framework for the evolutionary development of an Integrated AUTODIN System (IAS) on a terminal-to-terminal basis to include architectural design considerations for the 1979 to 1990 time frame.

The purpose of the Integrated AUTODIN System Architecture (IASA) is to guide the evolution of telecommunications systems toward a more efficient means of message processing and data communications while offering standard solutions to user requirements.

On 5 February 1975, OSD/DTACCS (now ASD/C^3I) tasked the Defense Communications Agency (DCA) in coordination with the Services/Agencies, to develop an IASA on a terminal-to-terminal basis and based on the architecture to define a common family of AUTODIN terminal hardware and software. On 12 December 1975, OSD/DTACCS approved the DCA IASA development plan. As a result of this plan, DCA is responsible for accomplishing three objectives: (1) develop a system architecture on a terminal-to-terminal basis; (2) develop terminal specifications; and (3) develop related standards, formats, and procedures.

The overall objective of the IASA project is to design and engineer a DoD-wide common-user system for communicating narrative and data traffic, for the period 1979 to 1990, based upon AUTODIN I and AUTODIN II, which is complete and integrated from end to end. The 1979-1983 implementation alternatives include determining the function, number and location of AUTODIN I Switching Centers (ASCs), AUTODIN II Packet Switching Nodes (PSNs), Automated Message Processing Exchanges (AMPEs), and user terminals. The 1984 to 1988 time frame will see the implementation of new hardware/software elements to replace obsolete equipments. The planning of a smooth transition over the 1979-1990 time frame is one of the important aspects of the IAS architectural strategy and is developed throughout this report. In addition to major network elements, this report covers such topics as user requirements, data communications trends, standards, security, allocation of functions, and the IAS transition strategy.

This report identifies three alternative architectures for the mid-term (1984-1988) IAS, and describes the process

and rationale for selecting the preferred (Alternative II) architecture. The preferred architecture for the mid-term represents a distributed architecture where services are provided from a common access area element. The major elements of the architecture are the AUTODIN II PSNs, the Inter-Service/Agency (I-S/A) AMPEs and subscriber terminals. This report identifies the roles and relationships of these mid-term IAS elements, identifies the I-S/A AMPE as the replacement for today's AUTODIN I switching centers and the current Service/Agency AMPEs, and recommends an architectural structure which moves switching functions closer to the user by use of the enhanced I-S/A AMPE. This approach, in consonance with recent planning efforts for DCS architectures, will reduce the dependency on the more vulnerable backbone switches and should enhance overall survivability.

Based upon the evaluation criteria of operational effectiveness, flexibility, survivability/availability/supportability, transition, and cost, the preferred mid-term architecture: (1) satisfies all of the identified services/functions; (2) offers significant cost reduction through standardization of hardware, software, and operating procedures; (3) provides improved access reliability; (4) permits improved speed of service; (5) provides flexibility in satisfying user unique requirements; (6) can be implemented in an evolutionary process from the near-term 1983 architecture; and (7) provides the framework for continued evolutionary development of the IAS through 1988 and beyond.

In contrast with the near-term IAS, which is constrained by the use of existing technology and equipment, the mid-term system begins to exploit the advantages of the state-of-the-art in communications. Accordingly, the mid-term transition strategy is driven by the following architectual objectives: (1) preserve continuity of existing network services; (2) provide for needed new services; (3) enhance system survivability; (4) enhance tactical and allied forces interoperability; and (5) replace obsolete equipment with new or augmented standard network elements (e.g. replace AMPEs with I-S/A AMPEs).

The December 1977 IASA Report (Part 1) provided AUTODIN implementation alternatives and recommendations through 1983. This report (Part 2) provides AUTODIN architectural alternatives and recommendations for the period 1984 through 1988. Section V provides conclusions and recommendations to this IASA Project report. In October 1979, an IASA (Part 3) report will be provided to include standards and functional specifications for a common family of terminals.

TABLE OF CONTENTS

Appendices

Page

LIST OF ILLUSTRATIONS

Figures 30-31 contained in Appendix 4
Appendix 4 is classified CONFIDENTIAL

LIST OF TABLES

Note: Tables 22-28 are classified CONFIDENTIAL

SECTION I

SECTION I

INTRODUCTION

A. Purpose. This report identifies mid-term, 1984-1988, Automatic Digital Network (AUTODIN) architecture alternatives and recommendations to meet user needs for common-user record and data communications.

The purpose of the Integrated AUTODIN System Architecture (IASA) is not to create a new system to be superimposed on all other user systems in a duplicate way, nor is it to exploit technological advances in the data processing industry when there is no well defined need to do so. The purpose of the IASA is to guide the evolution of telecommunications systems towards a more secure, accurate, survivable, and efficient means of message processing and data communications while offering standard solutions to user requirements.

This report identifies three alternative architectures for the mid-term (1984-1988) Integrated AUTODIN System (IAS), and describes the process and rationale for selecting the preferred architecture. In addition, this report identifies a transition strategy to evolve from the near-term (1978-1983) IAS architecture to the mid-term IAS architecture.

B. Background. In July 1974, the General Accounting Office (GAO) published a report that was critical of the Department of Defense (DoD) for (1) not having a single agency responsible for management of the entire AUTODIN system to include AUTODIN terminals; (2) for a poor telecommunications center consolidation record; and (3) for duplication of effort and proliferation of LDMX-type AUTODIN terminals by the Military Departments (MILDEPs) and DoD Agencies. The GAO recommended to OSD/DTACCS (now ASD/C3I) that a single AUTODIN manager be appointed to resolve the problems as they surfaced.

In February 1975, OSD/DTACCS acted on the GAO recommendation by tasking the Defense Communications Agency (DCA), in coordination with Services/Agencies, to develop an IASA on a terminal-to-terminal basis and based on that architecture to define a common family of AUTODIN terminal hardware and software.

In December 1975, OSD/DTACCS approved the DCA IASA development plan which would address the backbone, concentrators, and terminals as a single integrated system with processing functions allocated to system components on the basis of how and where they can best be performed. As

a result of this plan, DCA is responsible for accomplishing three objectives: (1) develop a system architecture on a terminal-to-terminal basis; (2) develop terminal specifications; and (3) develop related standards, formats, and procedures.

As an outgrowth of the OSD tasking, JCS Memorandum of Policy 165, titled: AUTODIN and Associated Message Processing Systems, was issued on 5 May 1976. Mop 165 establishes AUTODIN as the DoD common-user data communications system, directs maximum use of the system elements, identifies criteria for interservice telecommunications center consolidation and automation, provides safeguards to prevent proliferation of non-standard terminal systems, and provides policy and guidance for use of new equipments using automation techniques through the AUTODIN.

In December 1977, DCA completed its first IASA Report (Part I) which identified near-term (1978-1983) AUTODIN implementation alternatives and recommendations.

In October 1978, ASD/C3I approved the IASA Report approach and directed DCA to: (1) identify, develop and promulgate necessary standards; (2) identify the roles and relationships of components of the Integrated AUTODIN System; (3) establish an Inter-Service/Agency AMPE Program; and (4) complete the development of functional specifications for a common family of terminals.

C. Organization. The IASA Project organization is shown in Figure 1. Control of the project is exercised through the AUTODIN Systems Integration Branch (Code 534), Headquarters DCA. Technical support is provided by the Defense Communications Engineering Center (DCEC). Representatives of the DCA, MILDEPs, National Security Agency (NSA), Defense Intelligence Agency (DIA), and Defense Logistics Agency (DLA) are formed into a Technical/Policy Panel which serves as the forum for discussion of IASA issues. In addition, there are three working groups, each chaired by DCA, with participation from MILDEPs and DoD Agencies.

The IASA Project working groups were established to develop the required design baseline inputs. The Security Working Group objective is to insure that user security requirements are factored into the IASA and to insure that TEMPEST criteria are considered in selecting hardware to implement the architecture. The User Needs and Capabilities Working Group objective is to develop a data base containing

user functional requirements and capabilities and to perform detailed analyses of the various Automated Message Processing Exchanges (AMPEs) and terminals. The Standards and Procedures Working Group objective is to develop policy, procedures, and standards for message preparation, input, transmission, output, and distribution facilities.

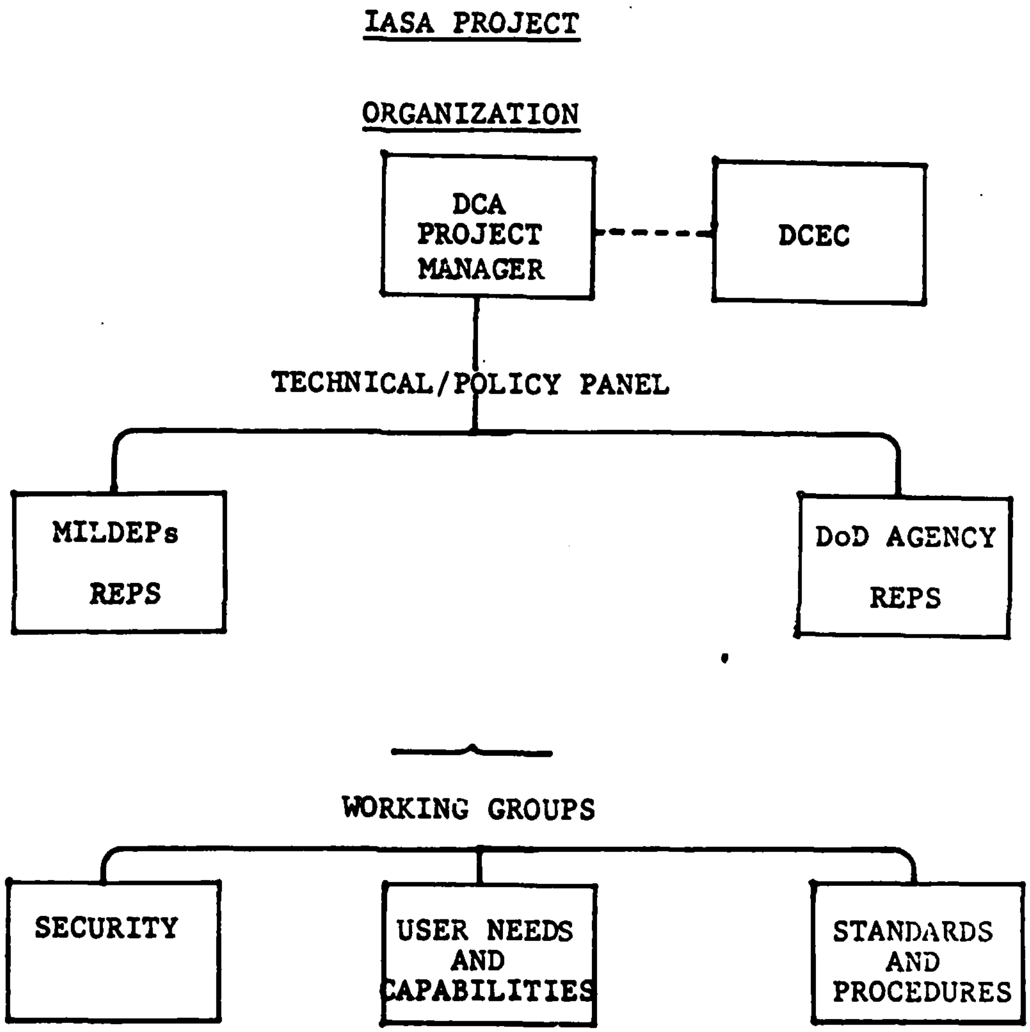


FIGURE 1

D. Scope. This report presents the results of the IAS Architecture definition process as it applies to the mid-term (1984-1988) time period. Previous effort in this process was directed toward identification and analysis of implementation alternatives for the near-term (1978-1983). This near-term work, described in the IAS Architecture Report of December 1977, was intended to shape decisions on the implementation and/or use of existing and readily available hardware/software components in order to achieve a near-term enhanced AUTODIN system capability. The mid-term architecture analyses, by contrast, were directed toward the definition of an overall top down system architecture and the definition of new system elements required to support this architecture. This report identifies the roles and relationships of the IAS components and addresses such topics as user requirements, data communications trends, standards, allocation of functions, and security.

Based on ASD/C3I guidance and overall AUTODIN system requirements, the major architectural objectives relevant to the mid-term are:

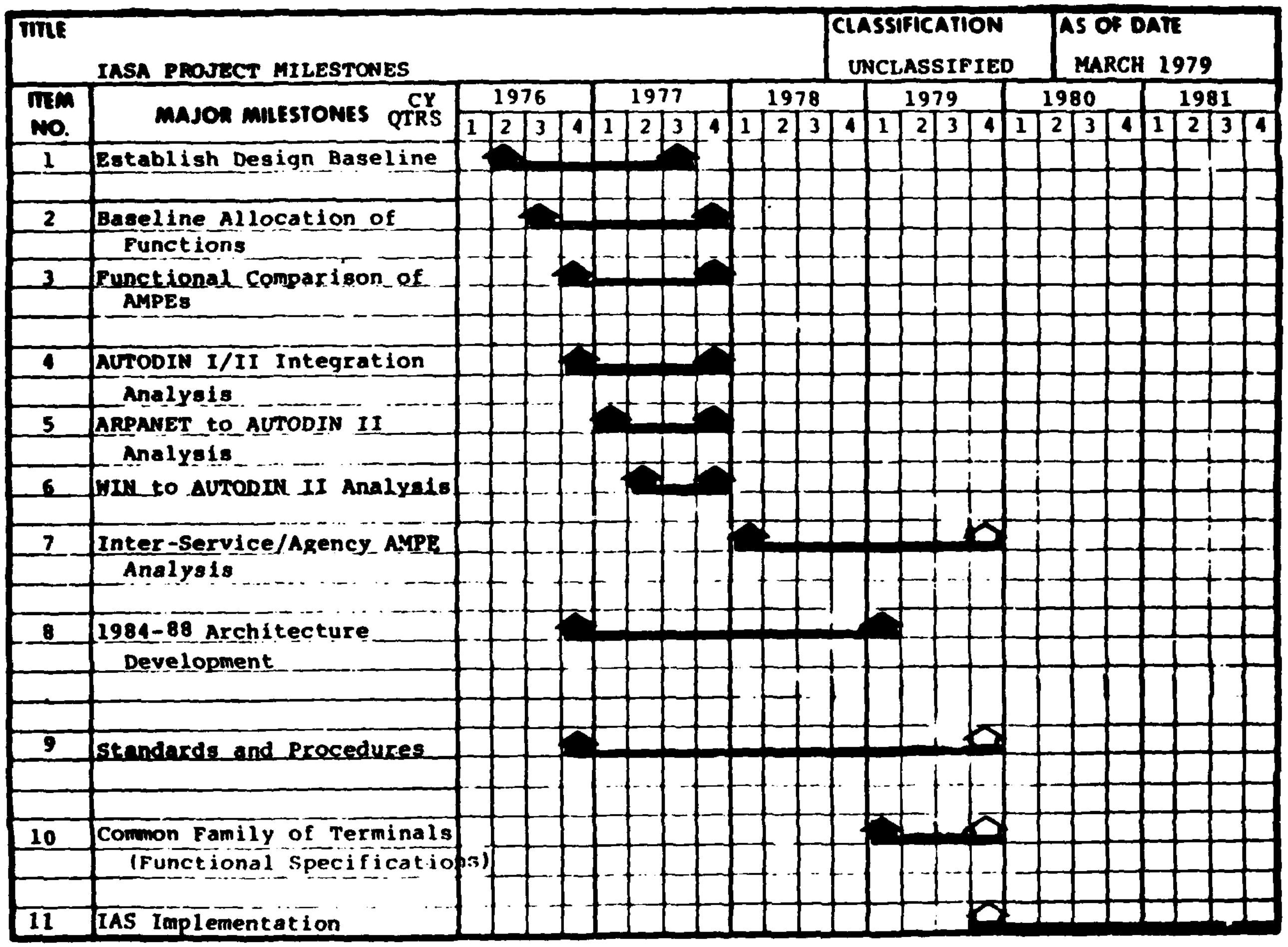
- Phase-out AUTODIN I switches
- Standardize terminals/AMPEs
- Reallocate ASC functions to new IAS elements
- Enhance system survivability
- Enhance interoperability to tactical and allied forces
- Determine allocation of new functions
- Accomplish the above objectives via evolution

Consistent with these objectives, the IAS architecture definition effort over the past year has been to:

- Project IAS user requirements to the mid-term
- Define viable mid-term candidate architectures
- Evaluate the differences among architecture alternatives
- Define the role of the Inter-Service/Agency Automated Message Processing Exchange (I-S/A AMPE)
- Define the IAS Security subsystem
- Recommend allocation of ASC functions among IAS elements
- Recommend a preferred mid-term architecture
- Define a transition strategy from the near-term to the mid-term

The preferred IAS architecture presented in this report satisfies all of the major objectives for the mid-term. In addition, the transition approach can be achieved in an orderly evolutionary process from the near-term to the mid-term and eventually into the far-term integrated AUTODIN system.

The IASA Project milestones are identified in Figure 2, which logically divides the project into three parts. The December 1977 IASA Report (Part I) provided AUTODIN implementation alternatives and recommendations through 1983. This report (Part 2) provides architectural alternatives for the period 1984 through 1988. In October 1979, an IASA (Part 3) report will be provided to include standards and functional specifications for a common family of terminals. Reference is made to Appendix 1 for list of acronyms.



TITLE
IASA PROJECT MILESTONES
CLASSIFICATION
UNCLASSIFIED
AS OF DATE
MARCH 1979
ITEM NO.
MAJOR MILESTONES
CY QTRS
1976
1977
1978
1979
1980
1981
1 2 3 4
1 Establish Design Baseline
2 Baseline Allocation of Functions
3 Functional Comparison of AMPEs
4 AUTODIN I/II Integration Analysis
5 ARPANET to AUTODIN II Analysis
6 WIN to AUTODIN II Analysis
7 Inter-Service/Agency AMPE Analysis
8 1984-88 Architecture Development
9 Standards and Procedures
10 Common Family of Terminals (Functional Specifications)
11 IAS Implementation

FIGURE 2

SECTION II

SECTION II

REQUIREMENTS

A. General. The purpose of this section is to identify user requirements as they are expected to exist in the mid-term (1984-1988) and to assess the data communications environment of the 1980's. The requirements identified in the IASA Report (Part I) for the near-term (1978-1983) remain valid for the purpose of determining the mid-term architecture strategies. In addition the extent to which the IAS will provide increased user satisfaction over the AUTODIN system of today is dependent, in part, on the advancing state-of-the-art in technology which offers considerable promise of increased capability at reduced costs.

The mid-term IAS, as an evolving network, will be influenced by requirements identified within on-going Service/Agency actions to include the following areas: telecommunication center consolidations, Automatic Message Handling Systems (AMHS), Advanced Research Project Agency Network (ARPANET) connectivity to AUTODIN II, WWMCCS Intercomputer Networks integration into AUTODIN II, AUTODIN billing structure, standards and the interface with tactical and allied forces. These architectural considerations are discussed herein as special items.

B. Evolving Data Communications Environment. The near-term IAS results from evolutionary developments of both the existing AUTODIN I and developments in the AUTODIN II program. During the near-term, one or more AUTODIN I Switching Centers (ASCs) will be closed. Common-user narrative/record service to DoD components worldwide will be provided by a network of Service/Agency AMPEs and terminal equipments, supported by ASCs connected via a combination of AUTODIN II Packet Switching Nodes (PSN) trunks and inter-ASC trunks. Interface between AUTODIN record/data users and allied/tactical users will be accomplished by designated interfaces to the NATO Integrated Communications System (NICS)/Teletype Automatic Relay Equipment (TARE) and the TRI TAC's message switches.

For planning purposes, a near-term 1983 baseline architecture is defined in order to provide a basis for mid-term (1984-1988) transition development. This baseline architecture is best described as a consolidated network consisting

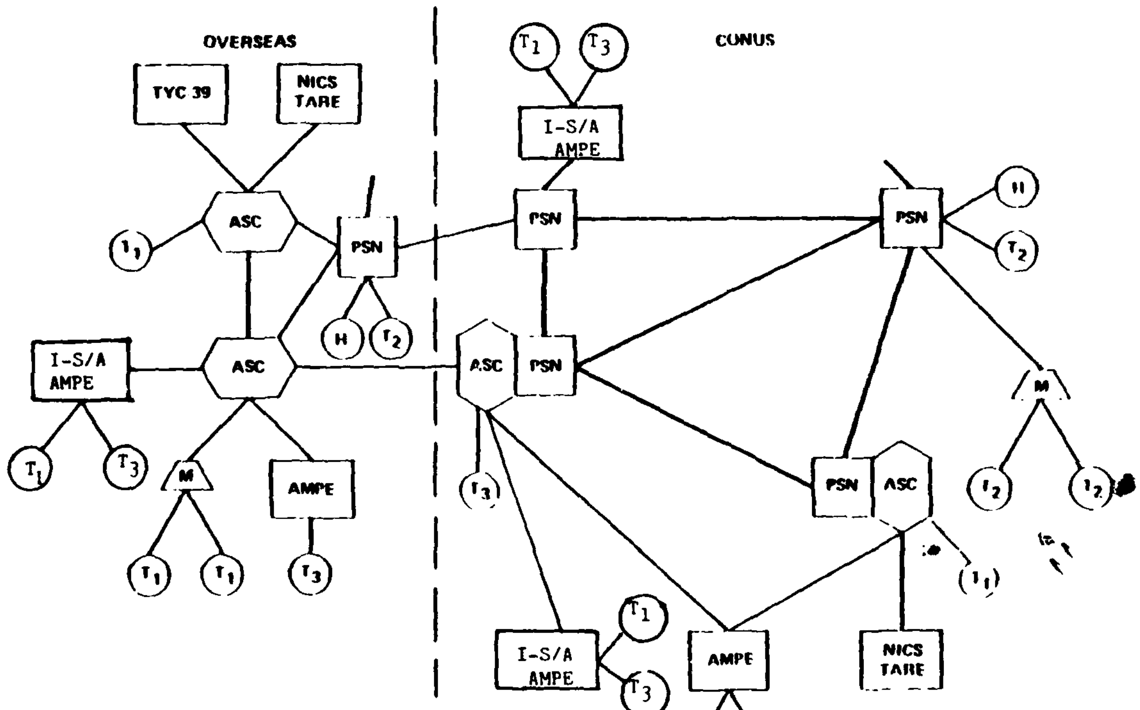
of two major subsystems, the AUTODIN I narrative/record subsystem and the AUTODIN II computer communications subsystem. The IAS architecture efforts throughout the near-term, however, will result in considerable degree of sharing of assets between these major subsystems as well as significant standardization of user terminals and local message processing equipments. In addition, the architectural developments of the 1979 to 1983 time period establish the groundwork for the integration of these two subsystems that will take place throughout the mid-term time period. By 1983, eleven to fifteen ASCs should be in operation (seven overseas, and four to eight in CONUS). Functionally, the ASC will be essentially unchanged from what exists today. It will continue to provide such store-and-forward functions as message retrieval, intercept storage, multiple address processing, code conversion, and format conversion. Also by 1983, it is expected that eight PSNs will be in operation (three overseas, and eight in CONUS).

The near-term IAS architecture provides an AUTODIN system that is, in general, responsive to the needs of both narrative/record and data users. On the other hand, the 1983 baseline architecture, illustrated in Figure 3, does not represent an acceptable conclusion to the integration process. Therefore, the need for continued evolution to a mid-term Integrated AUTODIN System Architecture is clear.

1. Major Subsystems of the Baseline Architecture.

a. AUTODIN I. The Automatic Digital Network (AUTODIN) I is a store and forward switched network of the Defense Communications System (DCS) which functions as a single integrated worldwide, high-speed, computer-controlled, general purpose communications network, providing secure record communications service to the Department of Defense (DoD) and other Federal agencies. AUTODIN I has been operational for approximately 16 years and has undergone numerous enhancements and expansions required to meet the growing DoD requirements for data/record communications. In addition, many additional enhancements and improvements are currently in process and/or planned for the AUTODIN I to keep it viable and responsive to the needs for data/record communications into the 1980s.

(1) CONUS. During 1976, an expanded memory system was installed at all eight CONUS ASCs as well as at the Hawaii ASC. This system consists of four disc units and two mini-computers at each switch. Another CONUS AUTODIN



T_1 = AUTODIN I TERMINAL (MODE I)
T_2 - AUTODIN II TERMINAL (MODE I, IB, IIA, VI)
T_3 = AUTODIN I TERMINAL (MODE *II, V, OR USER UNIQUE)
H - AUTODIN II HOST (MODE VI, BSL)
M = MULTIPLEXER

* NOT ALL MODES AVAILABLE AT ALL NODES

1983 BASELINE ARCHITECTURE
FIGURE 3

support project is the replacement of the magnetic tape stations and mass memory units with disc units at each ASC. In addition to significant cost savings, this enhancement provides a direct, high-speed, channel inter-connect to the AUTODIN II PSNs and will permit use of PSNs for digital trunking between ASCs.

(2) Overseas. To meet current forecasted operational requirements and to replace/refurbish worn out subsystems of the overseas AUTODIN I, DCA has also initiated several enhancement projects. These are: memory-memory control replacement; input/output controller, card reader, and high-speed printer replacement; magnetic tape subsystem replacement; and patch and testing facility upgrade. These enhancements, to be completed by December 1980, will insure operation of the overseas AUTODIN through at least 1985.

b. AUTODIN II. The AUTODIN II is a general purpose data communications packet switched network for integrating the teleprocessing and record communications needs of DoD into a single digital backbone system. The system will employ a short data handling unit or packet of bits to accommodate man-computer, computer-computer and/or computer-terminal data traffic. Each AUTODIN II PSN will: route and distribute packetized traffic (interactive, query-response, record, and bulk-data) over a full duplex wide-band trunking network; electrically interface with the AUTODIN I system through CONUS ASCs; terminate up to 200 lines (both individual and multiplex) per switch with a capability to service up to several hundred data subscribers; and accommodate dial-up access lines for low volume subscribers and emergency restoration. As a major subsystem of the DCS, AUTODIN II must provide data service at all levels of security from unclassified to Top Secret, Special Intelligence. To meet this need, the AUTODIN II communication links and switch facilities will be secured to the highest classification level transmitted, and will be capable of being compartmented by use of transmission control codes and virtual logical channels. Each data packet will be verified as to the authorized security level and community-of-interest of both the sender and receiver.

(1) CONUS. Initially AUTODIN II Phase I will consist of three PSNs at Ft. Detrick, Tinker AFB, and McClellan AFB with a Network Control Center at Headquarters DCA. The acceptance of this three node network establishes the FY 1980 Initial Operational Capability (IOC). Subsequently, a fourth PSN will be added at Gentile AFB. The growth of the network from that point will depend on user requirements and

user ability to provide the software and hardware interfaces needed to connect to the network. It is envisioned that the network service will grow incrementally, as required, to meet additional requirements.

(2) Overseas. AUTODIN II Phase II is defined as the overseas portion of the PSN implementation scheme. An IOC of FY 1981 has been identified in the DCS Five Year Program (FYP) 1981 for providing AUTODIN II service on a worldwide basis. With the validation of overseas user system requirements, it is expected that the location of PSNs overseas will be cost-effective. Identified to date are twenty-three Service/Agency subscribers of CONUS PSNs that have various hosts and/or terminals in overseas locations. Initially, these overseas subscribers will be connected to CONUS based PSNs by use of multiplexers or concentrators in order to reduce access line costs.

2. Baseline Architectural Elements. Major architectural elements are derived from AUTODIN I and II subsystems and are described in the following paragraphs.

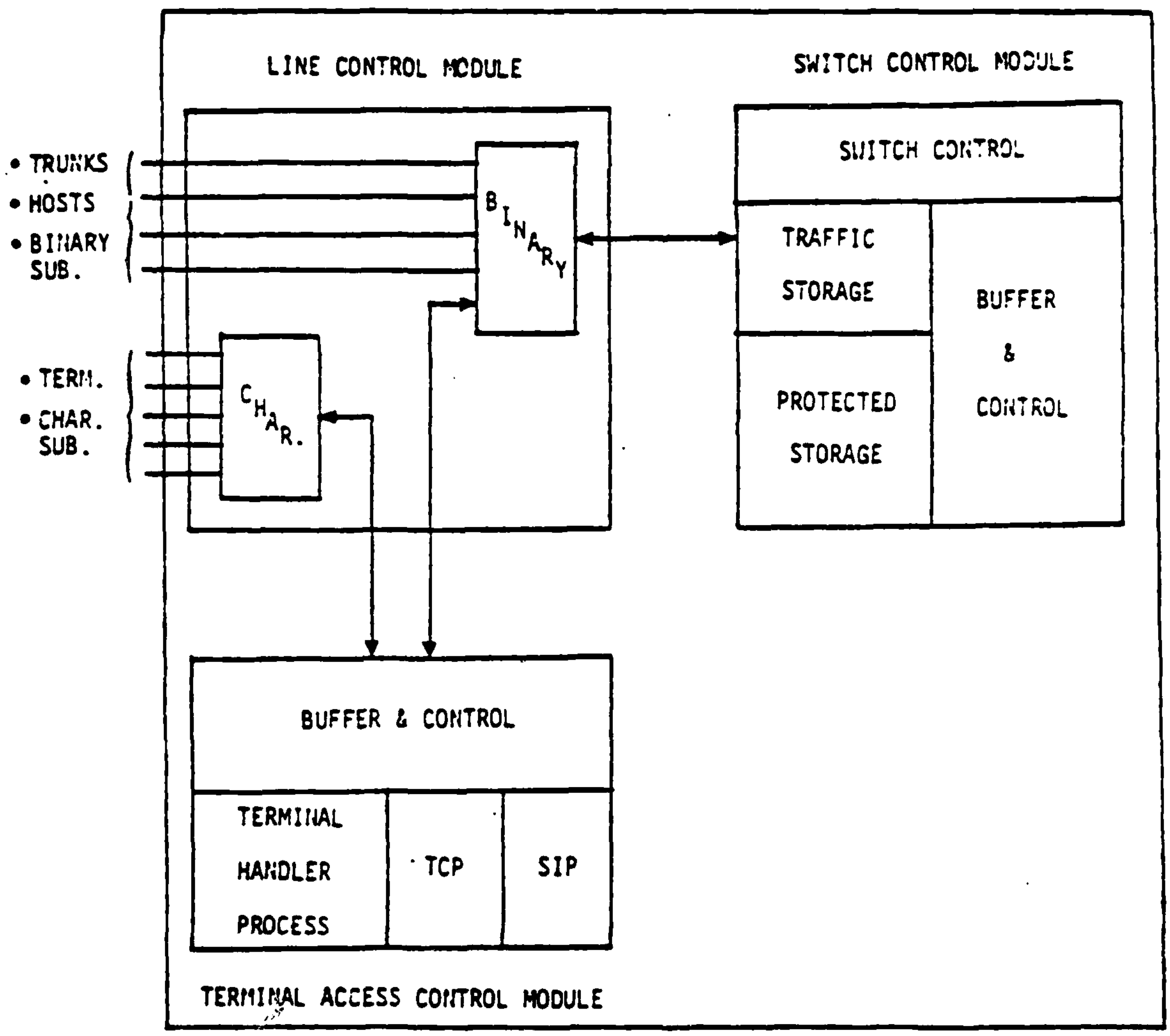
a. Packet Switch Node (PSN). The PSN is being developed under the AUTODIN II, Phase I program to provide backbone switching for both the AUTODIN II and AUTODIN I subsystems. A simplified functional block diagram of the PSN is illustrated in Figure 4.

As indicated in this figure, the PSN includes the following major subsystems:

(1) Line Control Module (LCM). The LCM provides the communications interface and protocol functions necessary to interface to trunks as well as host computers and terminals terminated at the PSN. The LCM transfers data to and from trunks in the form of packets, to and from host computers and other binary format terminals in the form of binary segments, and to and from character oriented terminals in the form of characters. The LCM exchanges data with the Switch Control Module in the form of both packets and segments as needed.

(2) Switch Control Module (SCM). The SCM performs the basic packet switching function within the PSN. The SCM accepts binary segments or packets from the LCM, processes the routing and control information contained in the data, and returns packets or segments to the LCM.

PACKET SWITCH NODE



PSN FUNCTIONAL BLOCK DIAGRAM
FIGURE 4

(3) Terminal Access Control (TAC) Module. The TAC is included in the PSN to permit character oriented terminal subscribers (both AUTODIN I and II) to use the PSN. The TAC includes a Terminal Handler Protocol (THP), Transmission Control Protocol (TCP) and a Segment Interface Protocol (SIP), which allow conversion between character format data and binary segment data for processing by the SCM. The TAC capability of the PSN can be implemented outside the PSN itself at remote terminal or host locations. In this case the remote TAC interface to the PSN is in binary segment format.

b. AUTODIN Switching Center (ASC). The 1983 baseline architecture should consist of eleven to fifteen AUTODIN I switching centers (four to eight leased in CONUS and seven overseas) and eleven AUTODIN II PSNs (eight in CONUS and three overseas). ASCs will terminate local subscribers and also terminate remote subscribers via the PSN backbone. Direct trunks between ASCs will be used to provide connectivity among allied/tactical users, overseas ASCs and ASCs colocated with PSNs.

c. Automated Message Processing Exchange (AMPE). The 1983 architecture will include Service/Agency operated AMPEs, such as the AMMF, LDMX, NAVCOMPARS, AF AMPE, and Streamliner. These AMPE equipments will provide local message processing and communications concentrator functions for narrative/record users. AMPEs will continue throughout the near-term to be homed on designated ASCs, either through direct ASC termination or through a TAC interface at a PSN.

d. Inter-Service/Agency (I-S/A) AMPE. Toward the end of the near-term, about 1982, some degree of AMPE standardization will be achieved through the introduction of a I-S/A AMPE. This near-term network element, while not capable of performing all AMPE functions, will perform a subset of functions including all the basic functions to provide standard services to its subscribers. It will terminate both narrative/record and some small ADP computer subscribers and be homed on an ASC and terminated either on that ASC or a PSN. (If terminated on a PSN the traffic will be handled on a cut-through basis to the home ASC.) Additional information on the upgrading necessary for the mid-term is provided later in the report.

e. Host Computers. Major high volume computer facilities in the Service/Agency communities, such as, WWMCCS and SACDIN, will interface directly to PSNs in the near-term architecture. These host computers are centers of major Automatic Data Processing (ADP) activities and will provide a major source of network traffic; low volume ADP facilities may be connected to ASCs or PSNs in a standard

mode or connected to AMPEs either in a standard or subscriber specified mode; large volume ADP facilities should be connected directly to PSNs.

f. Terminals. A wide variety of terminals will exist in the 1983 baseline architecture. Typical characteristics of the AUTODIN I and AUTODIN II terminals anticipated in this period are shown in Table 1. These terminals are defined as character oriented devices capable of conducting a single conversation and range from teletypewriters through software programmable computers.

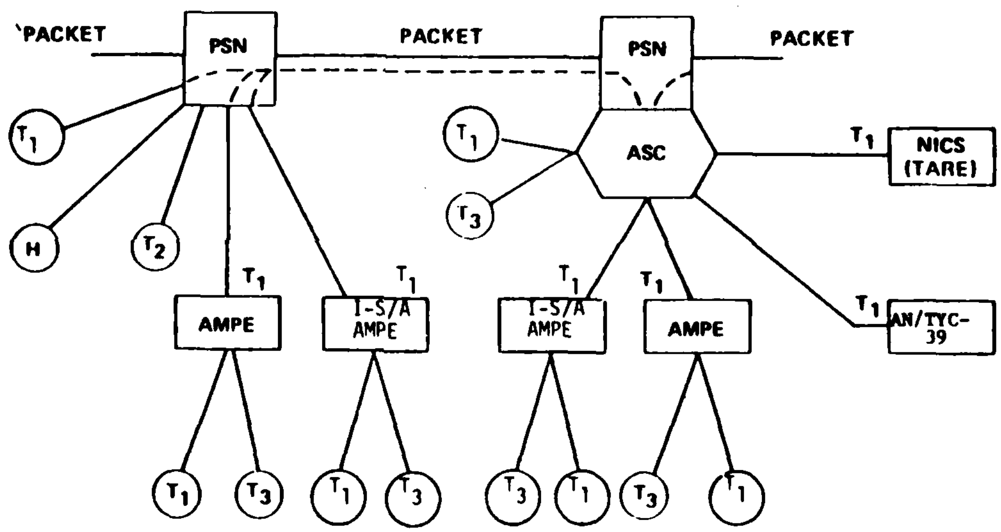
TABLE 1

BASELINE ARCHITECTURE TERMINAL CHARACTERISTICS

	Existing AUTODIN I Terminals	Anticipated AUTODIN II Terminals
Types	Teletypewriter, card, magnetic tape, facsimile, multi-media, computer interface AMPE	Teletypewriter, card magnetic tape, facsimile, CRT, sensor, multi-media, host computer
Protocols Modes	I, II and V	I, IB, IIA, VI Link Protocols and end-to-end host protocols
Codes	ASCII, ITA#2	ASCII, Others (Transparent to network)
Speeds	45 thru 4800 bps	110 bps thru 56K bps
Formats	JANAP 128, ACP 127	Binary and character segment formats, message formats transparent to network.

g. Multiplexers. Multiplexers will be used in the baseline architecture wherever practical in order to effect transmission efficiency and/or cost reduction.

h. Baseline Architecture Connectivity. The major interfaces that will exist in the baseline architecture are illustrated in Figure 5. The basic link protocol and interface characteristics of this architecture are described in Table 2.



T_1 = AUTODIN I MODE I
T_2 = AUTODIN II MODES I, IB, IIA, VI
T_3 = AUTODIN I MODE II, V OR USER UNIQUE*
H = AUTODIN II MODE VI, BSL
– – – – REMOTE HOMING VIA "CUT THROUGH"

* NOT ALL MODES AVAILABLE AT ALL NODES

BASELINE ARCHITECTURE CONNECTIVITY
FIGURE 5

TABLE 2

BASELINE INTERFACE CHARACTERISTICS

CONNECTION	LINK PROTOCOL
PSN-PSN	Binary Packet
PSN-ADP Host	Mode VI
PSN-ASC	Mode VI
PSN-Terminal	Mode I, IB, II or VI Character via Terminal Access Controller (TAC)
PSN-AMPE/Terminal	Mode I (via TAC)
ASC-ASC	Mode I (Switch to Switch)
ASC/AMPE-Terminal	Mode I, II, V
ASC-NICS (TARE)	Mode I
ASC-AN/TYC-39	Mode I

(1) Tactical/NATO Interfaces. These interfaces are provided through the AN/TYC-39 Automatic Message Relay developed under the TRI-TAC program and the NATO Integrated Communications System Teletype Automatic Relay Equipment (NICS/TARE). Interface to both of these systems will be accomplished via direct connection to designated ASCs. Overseas both the AN/TYC-39 and the NICS/ TARE interface will be accomplished through designated ASCs. In CONUS one or more of the colocated ASC/PSN sites will be designated as the NATO interface. It is anticipated that both the NICS/TARE system and the AN/TYC-39 relay will employ an AUTODIN I, Mode I, terminal interface and that this protocol will provide the basic access mechanism.

(2) Security. The 1983 baseline architecture will depend upon link-by-link encryption similar to that employed in the current AUTODIN I system.

i. Summary. The baseline architecture of 1983 will provide an AUTODIN system that is, in general, responsive to the needs of both narrative/record and data users. In defining the next major evolutionary step toward the Integrated

AUTODIN System in the mid-term, the following characteristics of the baseline architecture should be considered:

(1) The architecture of 1983 represents a consolidation of two essentially independent networks with significant sharing of backbone assets and two co-existing user communities with discrete operating procedures, access arrangements and equipment inventories.

(2) The architecture of 1983 represents an increase in the standardization of AMPE and terminal operation/configuration through introduction of Inter-Service/Agency AMPEs.

(3) The AUTODIN system of 1983 will provide significantly improved performance and service for data users through the capabilities of the AUTODIN II subsystem.

(4) The architecture of 1983 represents little improvement in system survivability, security, or operational flexibility over the current AUTODIN I system for narrative/record users.

(5) The AUTODIN system of 1983 represents improvement in cost effectiveness as a result of the closure of one or more CONUS ASCs and consolidation of ASC and PSN sites.

As a result of these and other architectural considerations, the baseline architecture does not represent an acceptable conclusion to the integration process. Therefore, there is need for a continued evolutionary approach to the mid-term Integrated AUTODIN System Architecture.

3. Trends.

a. General. Based on current DoD experience with new technology introduction, and the development cycle required for communications system implementation, new network elements to be introduced during the mid-term should be based upon available technology. This precludes the introduction during the mid-term of two of the principal long-term architectural objectives identified in previous studies, i.e., integrated voice and data and the use of multiple access satellite broadcast capability. However, the long-term promise of these technologies and the probability of their successful development cannot be ignored. Therefore, these advanced technologies are assumed to be available for far-term (post 1988) IAS implementation. In addition, the mid-term architecture definition will consider the impact of this eventual far-term evolution on the mid-term architecture itself, and thereby not preclude successful continued evolution of the IAS.

b. Technology Trends. The predominant trend in telecommunications relevant to the DCS is an evolution toward digital transmission and switching in the 1980s. The basic technology which has spurred the acceleration of digital switching is the Large Scale Integrated circuit technology. Microprocessors, semiconductors and magnetic bubble memories, phased logic arrays, and custom tailored chips have dramatically reduced hardware costs, decreased equipment size, and improved reliability and maintainability of telecommunications equipment. The nature of fiber optics lends itself more suitably to digital operation and this technology is rapidly making inroads in short haul and exchange area communications in the United States. Satellite communications technology continues to make impressive gains in cost and size of satellite terminals operating at higher frequency ranges. The trend here is also towards increased digital operation. Progress in digital computer technology has dwarfed developments in analog computer technology and has direct influence on AUTODIN as well as indirect impact on other aspects of the DCS such as system control and automated operation. These trends have influenced AUTODIN planners to consider structures where the intelligence of switching functions such as control, signaling, and protocols is physically located closer to the user and away from backbone nodes.

c. Economic Trends. Implementation of programs to upgrade the DCS is constrained by the DoD budget and, in particular, that portion of the DoD budget which supports the DCS. A second constraint is the amount of service or new equipment that can be procured for the available funds. A third constraint is the manpower available to operate the DCS.

(1) Funding Trends. Projection of current trends indicates that the percentage of the DoD budget available for telecommunications will decrease. While the funds available for the portion of the budget relevant to the DCS is expected to grow at a rate comparable to the inflation rate, leased charges are at present climbing at higher than the inflation rate. A constrained economic environment is projected for the DCS during the mid-term time frame.

(2) Trends in Tariffs. In overseas areas, tariff charges must be paid in the currency of the host country. For example, the German and Japanese currencies relative to the U.S. currency have risen 30 and 40% respectively during the period from January 1977 to January 1979.

(3) Trends in Manpower Availability. DoD manpower, military and civilian, is projected to remain approximately level in the immediate future. However, data from the

Army and Air Force obtained on the Frankfurt-Koenigstuhl-Vaihingen (FKV) digital subsystem over a one year period indicates that maintenance men are not required on a 24-hour basis because of the extremely high reliability and maintainability of the new equipment. As a result, some of the functions of maintenance and technical controls are being combined for operating the Digital European Backbone.

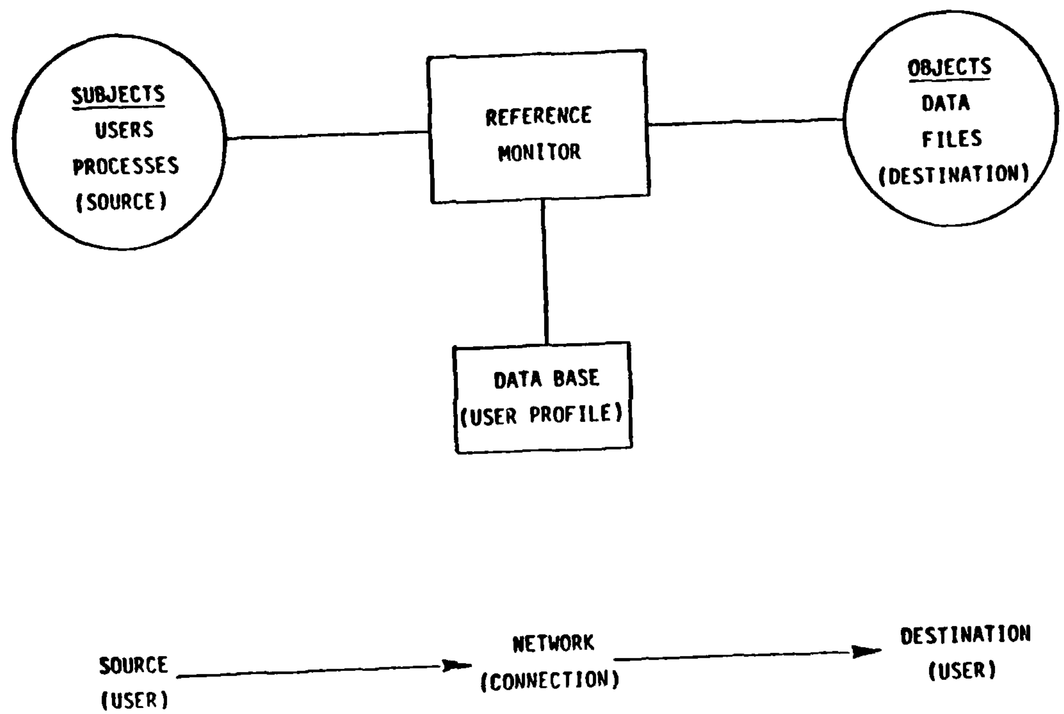
d. Security Trends. The maturity and availability of various security technologies during the IAS mid-term will be a major factor in achieving the system security goals. These technologies include not only new cryptographic and communications security techniques but also computer software security and access control/authentication techniques. The following paragraphs discuss the major technological advances applicable to the design and development of secure systems.

(1) Background. Based upon studies sponsored by the Air Force in the early 1970s, a model of a secure system was developed--the Reference Monitor (Figure 6). The Reference Monitor is a model of the operating characteristics of a hardware/software system whose purpose is to control the relationship between subjects--users of a system resource, and objects-members of a set of system resources. It is the function of the Reference Monitor to mediate every attempt by a subject to access an object. In response to this security concept, several software based prototype systems were developed which confined to a small portion of code the security relevant decisions concerning resource allocation. These implementations of the Reference Monitor have come to be known as security "kernels." Since these initial studies, considerable effort has gone into developing security kernels and operating systems for various systems. The following chronological list illustrates some of the more important events:

- 1971-1975; Bell Labs UNIX Operating System developed.

- 1973-1975; MITRE developed a prototype security "kernel" on PDP 11/45 and applied the concept to the MULTICS design.

- 1974-1975; UCLA developed a security "Kernel" architecture emphasizing a virtual machine monitor with a goal of "kernel" verification.



REFERENCE MONITOR
FIGURE 6

- 1975; MITRE and UCLA began adapting their kernels to support a prototype secure operating system compatible with UNIX. SDC began development of kernelized version of IBM VM 370 operating system.

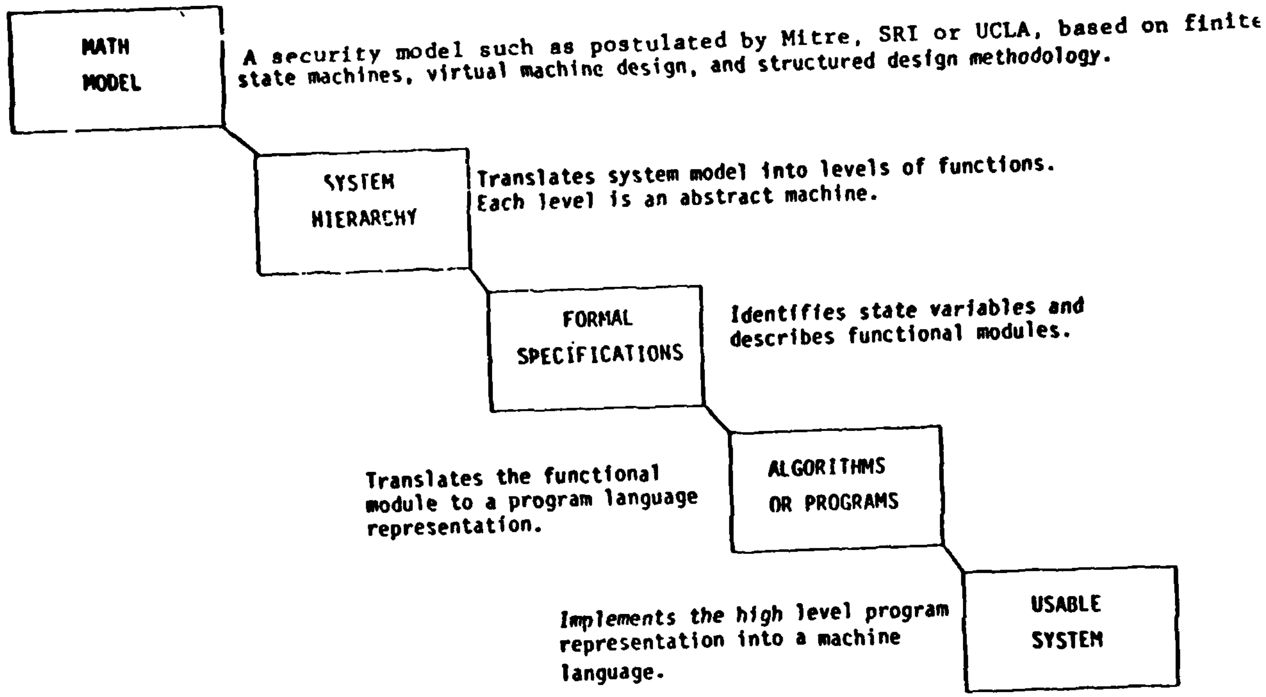
- 1977; SRI developed formal specifications for a Probably Secure Operating System (PSOS).

- 1977; ARPA began to develop a production quality version of the secure UNIX System called the Kernelized Security Operating System (KSOS).

- 1978; KSOS design phase completed. The implementation phase is being accomplished by Ford Aerospace and Communications Corporation (FACC).

(2) Security Reference Monitor Models. In order to define the Reference Monitor, system security behavior is designed to conform to a formal definition of security. Several models have been developed based on abstract mathematics which form the starting point of a verifiable secure design. These models include MITRE's Security Kernel Model and Stanford Research Institute's Hierarchical Development Model.

(3) Verifiable Secure System Design. Once the behavior of the abstract system has been proven with respect to security, the translation to a usable system must be accomplished in a manner that insures the final implementation can be certified. A validation chain such as the one illustrated in Figure 7 allows the design to proceed in small steps with each link in the chain representing the final implementation at different levels of detail. Specific validation procedures are applied in each step. The formal specification stage describes the functional layers and state environments of each of the abstracted modules of the Reference Monitor. The algorithmic or program development stage is a representation of the specified abstraction in a suitable high order language. The difficult portion of this step is that the security relevant programs must be proven correct so that ultimate certification of the machine code-the final step in the chain-will assure the protection of classified information.



DESIGN AND VALIDATION CHAIN

FIGURE 7

(4) Security Kernels. In order for a software security kernel to provide "security", the kernel must implement the Reference Monitor controls by mediating every access by a subject to an object. In addition, the kernel must be isolated to protect against unauthorized modification. Finally, the security properties of the kernel must be verifiable. There are several advantages to the security kernel approach, especially in a communications system environment. First, the security code is essentially put at the innermost or lowest level of the system. Therefore, it does not depend on other code for its correct operation, and the non-security related parts of the system can be modified with no effect on the kernel. Second, the kernel may be small enough with respect to the number of lines of codes that it can be verified as correct with respect to a proven security model.

(a) The goal of the KSOS effort is to develop a computer operating system compatible with the proprietary UNIX operating system, which supports multilevel security. The design of KSOS consists of a software kernel that supports the full facilities of an operating system capable of controlling multilevel secure processes. The kernel implements the security rules and mediates the interaction between subjects and objects based upon these rules. Although the initial implementation is targeted for the PDP 11/70, the KSOS design is being written in a systems level high order language (HOL) called EUCLID, which was designed to facilitate verification. Furthermore, the specification of KSOS in a high order language makes it more transportable to other processors. A matrix which illustrates characteristics of KSOS and several other important security kernel efforts is shown in Table 3. KSOS is the primary security kernel candidate for use in the relevant IAS network elements and user interface controllers. This assumption is based upon the intended applications of a verified KSOS and the 1980 timeframe in which good design prototypes should be available for evaluation and inclusion into the IAS design specifications.

(b) NSA has benefited from previous and ongoing software security R&D efforts. The BLACKER UNIX kernel is a modified version of the UCLA UNIX, and the BLACKER kernel basically supports the communications environment of the BLACKER I prototype systems. The secure version of the IBM VM 370 being developed by Systems Development

TABLE 3

A MATRIX OF SECURITY KERNEL CHARACTERISTICS

SYSTEM	OPR(s)	USE	STATUS	REMARKS
KSOS	ARPA/NSA/FACC	Communications interfaces network hosts, message & packet switches e.g., I-S/A AMPE, PSNs	Currently being developed by FACC; compatible with "UNIX"	Certified version will be available latter part of 1979
BLACKER "UNIX"	NSA/SDC	COMSEC controllers and interfaces; communications controllers e.g. BLACKER, SNFE, etc.	Currently being used for BLACKER prototype development. Adapted from UCLA "UNIX"	Presently being implemented in the *BLACKER* prototype to be operational in 1979
UCLA	ARPA/UCLA	General purpose secure Operating System (OS) commercial UNIX	Several versions of this OS have been implemented on PDP-11s verification is currently underway	First implemented in 1976
VM 370 "Kernelization"	ARPA/SDC	A secure version of IBM VM 370 OS suitable for MLS network hosts and message processing systems	A secure version of VM 370 is currently under test by SDC	Anticipated implementation by May of 1979
Secure	MITRE/ESD/HIS	Used primarily on large Honeywell mainframes in the Air Force Data Services Center (AFDSC). Suitable for "system high" applications.	The current MULTICS funding level is minimal: formal verification has not been completed.	Several versions of MULTICS are available from Honewell Information Systems (HIS)

Corporation (SDC) is an excellent candidate for Multilevel Security (MLS) IAS hosts. This effort is currently in the coding and testing stage and should be available by the end of 1979.

(5) Software Verification. The design of security into IAS processors will require that the security behavior of the system be verified. Several efforts directed toward the specification and implementation of secure software have reached the stage where they may be applied to engineering development applications. Systems such as AUTODIN II, KSOS, Black-Crypto-Red (BCR), BLACKER, (see paragraph 4 of Appendix 4.) etc., have begun to apply these technologies, so that considerable experience should be gained in time for application to the mid-term IAS. The selection of a specification language and an implementation language for the IAS secure software will benefit from a detailed evaluation of the efforts mentioned above.

(6) Secure Protocol Design. Experience with the design of major communications systems requiring security has demonstrated the importance of security consideration in the development of communications protocols. Considerations of reliability and efficiency have already led to a realization of the need for improved techniques to specify and analyze communication protocols. Improved specification techniques, such as finite state machine representations, have begun to receive attention in the research community. DCA will apply as much of this protocol development methodology as is practical in the development of protocols for the mid-term IAS.

(7) Advanced COMSEC Techniques. AUTODIN II will initially offer subscribers essentially the same security capabilities as those available today in AUTODIN I. The baseline security capabilities to be offered by AUTODIN II using conventional COMSEC techniques are listed in paragraph 2 of Appendix 4. The operating and maintenance costs associated with providing this security capability to AUTODIN II are high. These costs include several elements.

- Distribution costs associated with manual dissemination of keying material.
- Maintenance costs associated with obsolete technology.
- Personnel costs associated with providing a large number of operation/maintenance personnel with security clearances for the switches and crypto devices.

- Physical security costs associated with protecting the switches, crypto devices, and keying material.

The maintenance costs attributed to the crypto devices can be reduced by replacement of these devices with modern, highly reliable link key generators with electronic keying capability, which should also help reduce costs associated with distribution and storage of hard copy keying material. However, personnel/physical security costs of the system would be largely unaffected and the security deficiencies addressed in paragraph 2 of Appendix 4 would still remain.

C. Mid-Term Requirements and Operating Environment. The mid-term architecture for the Integrated AUTODIN System (IAS) will provide an architectural framework for the evolutionary development of the AUTODIN during the period 1984-1988. The IAS architecture is not intended to represent a new system that must be developed and superimposed on existing common user DoD systems in a competitive or duplicative manner. It is rather intended as a vehicle to guide the evolution of DoD data telecommunications towards a more secure, survivable, efficient, and cost effective means of satisfying both narrative/record and data communications requirements throughout the 1980-1990 timeframe. This section presents the projected user requirements for the mid-term IAS and defines the anticipated environment in which the IAS should operate.

1. AUTODIN I. Currently installed AMPEs and terminal equipments of the AUTODIN I, as well as those installed during the period 1979-1983, will have a useful life extending into (and in some cases through) the mid-term time frame. The evolutionary implementation of the IAS precludes the wholesale replacement of these equipments during the mid-term. Therefore, the mid-term architecture must provide for support of AUTODIN I, Mode I-V, character format terminals and AMPEs throughout the mid-term time frame. The implication of this constraint is most significant upon the functional definition of the nodal elements which must interface these current inventory AUTODIN I AMPEs and terminals. In addition to providing the link protocols, the nodal elements required to support surviving AUTODIN I subscriber equipments must also provide all terminal support functions formerly provided by the ASCs. This has the effect of defining the minimum functional capability of these nodal elements.

a. Traffic Requirements. Based upon current traffic trends, the AUTODIN I traffic growth through 1980 is projected at 5 percent per year for messages and 11 percent per year for lineblocks. Since some computer oriented users of AUTODIN I are expected to convert their bulk traffic to AUTODIN II, a decrease in the rate of growth in AUTODIN I traffic is expected after AUTODIN II is implemented. AUTODIN I message traffic growth, therefore, is projected at 3 percent per year after 1980, with lineblocks increasing at a rate of 6 percent per year. These projections result in a total AUTODIN I busy hour input traffic volume of 1.2×10^9 bits or an average of 334 kbps in 1988. The current exchange of information between users of the AUTODIN is in the form of narrative text, card data, and magnetic tape data message traffic. Supporting these exchanges are the formats for entry and exit from the switched network including JANAP 128, JANAP 128 modified, and ACP 127.

b. Terminal Requirements. The number of access lines connected to AUTODIN I ASCs has remained relatively constant in CONUS and overseas for the period 1970 to 1978. The number of AUTODIN I terminals connected to the network is about 850 in CONUS and 450 overseas. In the near-term the trend toward relocation of terminals as remotes to AMPEs is expected to offset any increases in user requirements for additional terminals. Therefore, the projected AUTODIN I subscriber population for the mid-term is estimated at 850 in CONUS and 450 overseas.

2. AUTODIN II. The IOC of AUTODIN II will provide 4 PSNs with option for additional PSNs. This network of up to 8 PSNs will provide the backbone for the mid-term Integrated AUTODIN System. Based on an IOC of December 1979 and the advanced degree of definition of network operating modes, protocols, and interfaces, it is not considered feasible to significantly change the design of these elements. Therefore, the mid-term IAS architecture will be based upon use of these PSNs with minimum essential modifications.

a. Traffic Requirements. Preliminary IAS requirements estimate the total AUTODIN II busy hour traffic input (exclusive of AUTODIN I traffic) at 4.74×10^9 bits in 1982. A rapid growth in traffic volume to this level can be expected as subscribers are phased into the system between mid-1980 and mid-1982. After 1982, the growth will probably level off to that of a mature system. The increase in the volume of this type of traffic was, therefore, estimated at 11

percent per year. The AUTODIN II, Phase I System Performance Specification (Type A) provides estimates for the relative proportions of transaction and average transaction length by traffic type. It also estimates the ratio of computer to terminal input traffic. These estimates were used to derive traffic volumes by transaction type and subscriber type. The results are shown in Table 4.

TABLE 4

AVERAGE BUSY HOUR TRAFFIC INPUT FROM AUTODIN II TYPE SUBSCRIBERS (1988)

	Input Rate	
Traffic Type	Terminals (kbps)	Computers (kbps)
Narrative/Record	99	22
Bulk	207	2089
Interactive and Query/ Response	5	36
Total	311 kbps	2158 kbps

b. Terminal Requirements. The number of terminals (exclusive of AUTODIN I) and host computers connected to AUTODIN II PSNs by 1982 is estimated to be approximately 1300 and 150 respectively based on current validated Service/ Agency requirements. The rate of growth in AUTODIN II terminals and computers connected to the network beyond 1983 is dependent on many factors including: user data processing requirements; growth of distributed processing use in DoD; network service offerings; and Service/ Agency policy. Therefore, it is unlikely that a significant number of new requirements will be identified and validated for the 1984-1988 time period immediately following the AUTODIN II implementation. For these reasons, a modest growth rate is anticipated for the period immediately following implementation. The projected 1988 AUTODIN II total terminal/host population based on this growth rate is approximately 1800 terminals and host computers.

3. Inter-Service/Agency AMPE.

a. Definition. The I-S/A AMPE program, as defined in the December 1977 IASA Report (Part I), provides for the replacement of current Service/Agency AMPE programs by 1983.

The referenced report also provided the architectural provision for including AUTODIN I backbone functions in an enhanced I-S/A AMPE. In a recent ASD/C3I memorandum the DCA was directed to establish an I-S/A AMPE program as an initial step toward successful implementation of an Integrated AUTODIN System. The DCA has since developed a management approach to the implementation of this program and received ASD/C3I approval.

(1) The program is divided into two phases. Phase I is defined as the near-term basic program element, which includes the majority of functions now performed within the Services/Agencies current AMPE programs. Standard AMPE functions will be defined and developed leading to procurement based upon joint functional specifications. By this phase I approach, the first I-S/A AMPE should be fielded during fiscal year 1982. Phase II is defined as an upgrading of the I-S/A AMPE developed in Phase I to include programming in Ada or some other High Order Language, provision of an AUTODIN II Mode VI interface to PSNs, a Virtual Message Protocol allowing I-S/A AMPE to I-S/A AMPE interchange of message traffic via the PSN backbone, a remote TAC allowing termination of character oriented AUTODIN II subscribers, and adding AMPE functions not provided by the Phase I version. In addition, Phase II will provide the capability to facilitate the phase out of the ASCs and the facilities to offer new network functions and services.

(2) In developing a management approach to this program, AMPE requirements for the Air Force and the Defense Logistics Agency have been identified which cannot be met with AMPE hardware currently under contract and other requirements may arise before 1985. The Air Force has the majority of such requirements identified to date and submitted a management plan to DCA whereby they will meet all new Service/Agency AMPE requirements prior to 1985.

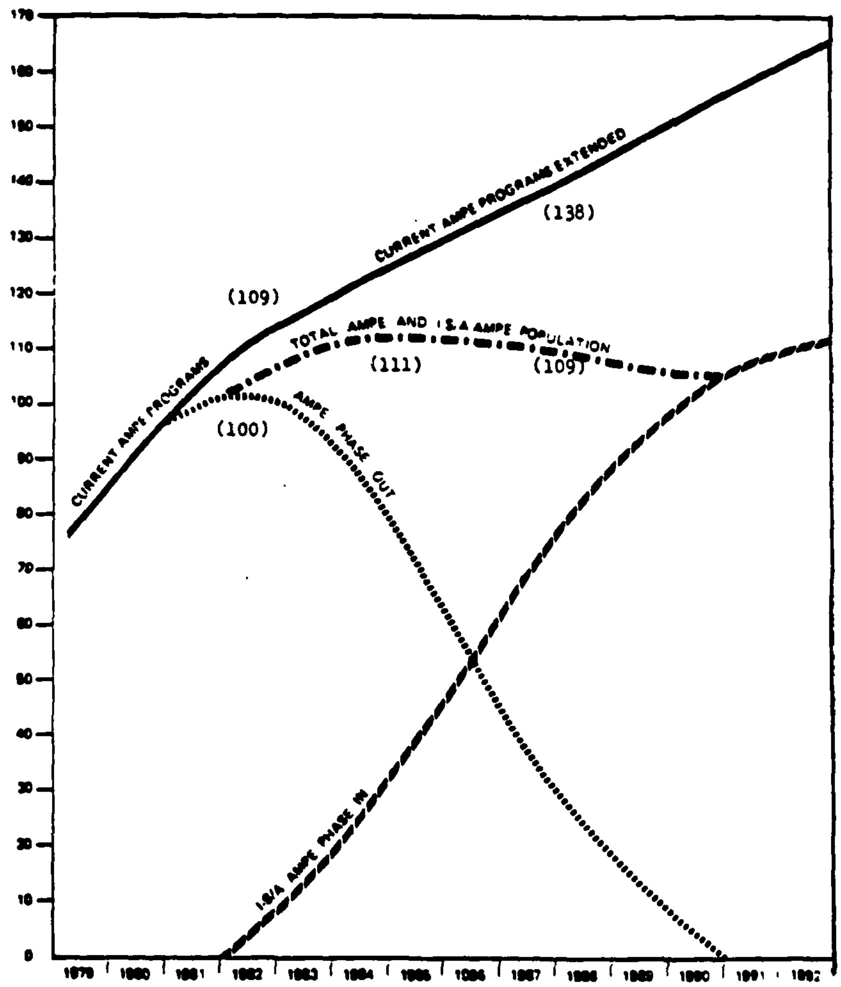
(3) DCA will exercise overall management responsibility for system development, chair the Configuration Control Board, monitor and control the requirements data base, and approve specifications to insure that validated requirements are satisfied. To assist in the implementation effort, Air Force has been identified as the DCA agent to work with the other Service/Agencies to define requirements, acquire hardware, develop application software based upon their available macro language, and other system functions.

(4) The capability obtained through this phased approach is responsive to user needs and is in keeping with ASD/C3I guidance to achieve an Integrated AUTODIN System in an evolutionary manner.

b. Requirements. During the mid-term time period, the majority of current AMPE equipments installed between 1970 and 1980 will reach the end of their useful life. The new Inter-Service/Agency AMPE will be used to replace these AMPEs, as well as to meet new AMPE requirements. In addition, since the I-S/A AMPE will be functionally capable of supporting Service/Agency requirements at all security levels, a number of current AMPE sites should be consolidated through joint use of the I-S/A AMPE. In order to project the total AMPE and I-S/A AMPE population in the mid-term IAS, an analysis of current and planned AMPE sites was performed (See Appendix 2). Results of this analysis are summarized in Figure 8. As illustrated in this figure, total population of AMPE/I-S/A AMPE sites will peak at approximately 111 in 1984 and eventually settle to less than 109 in 1988. It should be noted that this represents approximately 21% less than the number of AMPE sites required if the current AMPE programs were extended at even a modest 4 percent rate of growth. In addition, the actual number of AMPE installations in the mid-term will be based upon many factors not considered in this analysis, such as specific Service/Agency operational and survivability requirements. The results of this analysis are, therefore, intended only to support the architecture definition process and are not proposed as a replacement/consolidation policy.

4. Terminals.

a. Definition. A user terminal is that input/output device which is the ultimate source and destination of the data traffic being handled by the network. All intermediate sources and destinations of traffic (e.g., an AMPE) are nodes where communications services are performed. Previously all subscribers directly connected to ASCs were lumped together as terminals without regard to their actual hierarchical status. Thus, AMPEs were labeled as AUTODIN terminals even though AMPEs function as nodes, not user terminals. (Note: It is possible that some devices may be labeled as AMPEs which perform user terminal functions in addition to the normal nodal functions associated with AMPEs.) Depending on functional use and hierarchical location, such a device



PROJECTED AMPE/I-S/A AMPE REQUIREMENTS
FIGURE 8

will be functionally designated as either a node or a user terminal. Functional specifications for a "Common Family of AUTODIN Terminals" also apply to AMPEs.

b. Requirements. The variety of terminal equipments in use today require program support of significant degree considering training, maintenance, software support, and logistics. The existence of multiple terminal programs is due to differences in functional requirements and the existence of competitive equipment. Since not all terminals have equivalent capability, it has been necessary for the Services/Agencies to assume program responsibility for various terminal equipments to ensure the spectrum of communications requirements are satisfied cost-effectively. A corresponding overlap in the functional capability of competitive equipment is based on the competition for government dollars. Consequently, the Services/Agencies have been afforded the opportunity to be selective in terminal equipments, tailoring their terminal to precisely meet needs. The result is they have assumed program responsibility for terminals from different manufacturers, with similar capabilities to other Service/Agency terminals.

(1) The following is a listing of known programs developed by the Services/Agencies for terminal equipments provided by level of message processing requirements. Reference is made to the IASA Report (Part I) for detailed information on terminal requirements within the four levels specified.

(a) Level I-Teletypewriter (TTY) equipment. Requirements involving only narrative traffic at low speeds (asychronous) are satisfied using TTY.

(b) Level II-Digital Subscriber Terminal Equipment (DSTE). Requirements for card and narrative traffic (Mode I) are in part satisfied by the DSTE.

(c) Level III-Standard Remote Terminal (SRT). Requirements for terminals servicing as input/output devices directly connected to AUTODIN or as backside remotes to AMPEs and having the capabilities of narrative, card, and magnetic tape are in part satisfied by the SRT.

(d) Level IV-Automated Terminals. Requirements involving automation of processing functions for card, narrative, and magnetic tape traffic are satisfied by a multitude of programs to include AMPEs.

(2) Enroute to developing terminal specifications, for application in the mid-term time period, user needs and capabilities have been profiled within the four terminal levels in order to highlight potential areas for standardization.

(a) Level I. Separate Service/Agency programs for replacement of aged or obsolete TTY equipment where identified to the JCS as candidates for development of a common family of terminals. Consistent with the user needs and in response to a joint ad hoc working group report (Replacement of Obsolete TTY, October 1978), JCS assigned the Air Force as the Executive Agent for the replacement of about 5200 obsolete TTY equipments. In addition, the JCS assigned the DCA as chairman of the Joint Terminal Configuration Control Board to be formed after the validation of the Common Family of Terminals specifications. This joint program direction is consistent with the IASA project objectives and satisfies the standard terminal functional specifications for Level I capability.

(b) Levels II, III, & IV. To provide an orderly process in developing functional specifications for the common family of terminals within these levels, a terminal characteristics questionnaire was completed by the Services/Agencies.

1. In the three levels surveyed, 27 systems were identified and data collected on each. These systems exhibited like characteristics, however, the survey did point out some differences in processing speed, degree of automation, dependency on another network element, and processing parameters. Also, for the period 1975 through 1978 the net change in AUTODIN I medium speed (600-1200 baud) and high speed (2400-4800 baud) terminals has been an increase of 64 with a corresponding decrease of 61 in low speed (300 baud and below) terminals. Over the same time period, a total of 96 Mode V (75 baud) AUTODIN I terminals have been eliminated, with an increase of 85 Mode II terminals.

2. Analysis of these terminal characteristics will continue in order to provide the necessary information to prepare common family of terminals functional specifications.

5. Security.

a. Definition. The development of an architecture for the mid-term IAS requires that many technical, engineering,

functional and policy factors be investigated. One of the major issues to be investigated is that of effectively satisfying security requirements. The evolving IAS imposes new and challenging demands on system design in the area of security and access control. As the AUTODIN II system evolves into the IAS and the current AUTODIN I is phased out, the IAS will be increasingly required to support a wide mix of user communities and to provide a variety of network services, many of which are not available in the present AUTODIN system. This integrated collection of users and services will require the network security functions to share the responsibility for maintaining user community separation, controlling user access to network services, controlling network access to community resources, and ensuring the overall integrity and protection of subscribers from hostile external elements. Meeting these responsibilities requires that multi-level computer security disciplines and advanced COMSEC techniques be employed as appropriate. Security measures have historically been added to a system after the basic system design is done. This practice often results in a less than optimal security architecture and degradation of overall system performance. To prevent this from occurring in the mid-term IAS, security is being included as a major factor in early system planning, architecture development and system design.

b. Requirements. The initial phase of AUTODIN II will provide the same security services and capabilities as does the current AUTODIN I system. AUTODIN II will employ the same conventional COMSEC but will incorporate multi-level security techniques, which will provide user authentication and security kernel segregation of classified traffic. As the IAS begins to evolve from AUTODIN II into a mature, fully integrated backbone network providing a variety of network services to a wide mix of user communities, it is unlikely that the conventional COMSEC techniques will be sufficiently sophisticated or cost-effective for the encryption. Controlling access, maintaining user separation, and protecting user information within the IAS will be handled by the multi-level security techniques. Thus, the mid-term IAS should include the upgrading of security services and capabilities, as an integral part of the overall system evolution, through the application of advanced COMSEC and by applying multi-level security techniques to all elements of the IAS architecture. The IAS security subsystem should satisfy three basic requirements: (1) provide a transparent secure switching/transmission system for subscribers using the IAS as a basic communications backbone; (2) provide subscribers secure special network services; and (3) provide reliable security services with minimum system life cycle costs.

(1) The first requirement responds to the policy that the IAS will be the single major data communications network for DoD. If this IAS program objective is to be achieved, then special user communities (e.g., WWMCCS, SACDIN, DODIIS, etc.) should be able to use the IAS as a basic communications backbone with the confidence that their security requirements are maintained by the shared IAS network as effectively as they would be by a private, dedicated network.

(2) The second requirement responds to the philosophy that IAS will provide subscribers with special network features and services, beyond message/data transmission and switching, such as automated message processing, informal message exchange, data teleconferencing, etc. If these network provided services are to be of real value to a subscriber, they must incorporate the necessary safeguards to insure user privacy and permit the processing of classified user information.

(3) The third security requirement is to provide users with end-to-end security protection through the integrated application of conventional and advanced COMSEC techniques and computer multilevel security techniques.

(a) End-to-End Security. In the IAS, end-to-end security simply means that a subscriber's *information* is provided a secure virtual path from its source through the network to its destination. This secure virtual path protects the subscriber's information from unauthorized access, disclosure, modification, or destruction. The path is created in different ways depending upon a user's needs and capabilities. For example, one class of users with highly sensitive data will be provided a secure path through the network using end-to-end encryption (E3) techniques. The E3 users will be fully protected using a single encryption/decryption process between source and destination.

(b) Link Encryption. Another class of users will rely on the conventional AUTODIN I/II link encryption approach for end-to-end security through the network. These non-E3 users will undergo multiple encryption/ decryption processes between source and destination. Although their data will appear unencrypted within intermediate Nodes, the integrity of their end-to-end secure patch will be maintained by employing computer multilevel security techniques, physical security, and personnel security at the PSNs to protect the unencrypted data.

(c) Computer Multilevel Security (MLS). The MLS techniques will also be a major factor in providing complete end-to-end security to both E3 and non-E3 users when accessing network service processors. The network will provide secure paths to these service processors. Once the service processor is accessed, then MLS techniques will permit users with various security requirements to simultaneously obtain service from a common processor. The mix of security levels permitted within a network service processor will depend on the ability to certify and accredit MLS hardware and software for these processors. However, it is envisioned that the mature IAS will eventually offer network services from a common machine to users with security requirements ranging from unclassified through Top Secret and Special Intelligence. In addition, subscribers may apply MLS techniques within their own host processors to achieve a similar capability to share those resources among users with differing security requirements.

6. New Elements. As part of the architecture definition process, the following network elements could be developed and implemented in the mid-term:

a. Central Service Facility (CSF). The CSF is a postulated new centralized network service element that would perform necessary user support functions and/or network functions to accomplish message delivery and provide needed user services. The CSF is accessed via the backbone network and does not directly terminate subscriber equipments. The CSF would connect to the network via the PSNs through an AUTODIN II host computer interface. The specific functional capability of the CSF is dependent upon the architectural alternative selected.

b. Inter-Service/Agency AMPE Enhanced (Phase II). This new element is postulated as a network service element that can be derived from installed I-S/A AMPEs through modular expansion of software (and if necessary hardware). The I-S/A AMPE(E) would, therefore, include all of the functions of an I-S/A AMPE as described above and replace a normal I-S/A AMPE in the network at selected locations. In addition, the enhanced I-S/A AMPEs would provide the additional network functions needed to allow phase out of existing ASCs and provide new functions allocated by the architecture. The I-S/A AMPE(E) would terminate both narrative/record and computer data oriented users and connect to the network via

an AUTODIN II, host computer interface. The functional capability of the I-S/A AMPE(E) depends on the architecture alternative.

c. Common Family of AUTODIN Terminals. A new family of terminal equipments is being defined as part of the IASA project. This common family will include a full range of terminals from simple teletypewriter to automated user terminals. The functional capabilities of these terminals will be defined on the basis of user requirements and are independent of the architectural alternatives selected.

7. Functional Requirements. The mid-term IAS will provide many of the telecommunications capabilities which exist within the current state-of-the-art but are not now fully exploited. The IASA Part I report discussed a number of these telecommunications capabilities as part of the IAS architecture definition process, such as teleconferencing, word processing, internetting of data bases and networks, and facsimile. These capabilities will include the basic narrative/record services currently provided by the AUTODIN I system, the new computer oriented services defined for the AUTODIN II system, and several new data services. During the IAS architecture definition process a number of basic functional requirements were identified and defined. It is anticipated that additional requirements will be defined throughout the near-term based on user experience with the AUTODIN II system and evolving data needs. The mid-term functional requirements are organized into the following seven categories of service:

a. Narrative/Record Message Transfer. This service includes the secure user-to-user transfer of message traffic provided by the current AUTODIN I System. Using this service any user in the system (equipped with appropriate terminal equipment) may transmit narrative/record traffic to one or more other users. The major service features provided by the network are message accountability and retrieval, multiple/collective address routing, and code and format conversions. This service will be available to all IAS subscribers in some form.

b. Narrative/Record Message File Retrieval. This service provides storage of message traffic on-line for retrieval upon request from users. Narrative/record messages passing through the network are automatically stored for a prescribed period of time. Other data such as standard forms may be also stored by a user for later recall. The

nodal elements which contain the message files perform the processing to store messages, control access to the files and remove messages from the file at user direction or time expiration. The service is presently provided in various forms by some AMPEs in the current AUTODIN I system, and should be provided to all narrative/record subscribers of the IAS.

c. ADP Transaction Transfer. This service provides secure interactive, query/response and bulk data transfer as presently defined for the AUTODIN II network. No message processing functions or accountability are provided by the network. Traffic entered into the network contains segment leader information and is routed through the network on a packet basis. Only packet or segment intransit storage is provided. This service should be available to computer oriented IAS subscribers.

d. Privacy Service. This service is equivalent to the present AUTODIN I Limited Privacy Service. The traffic is handled as normal narrative/record traffic except that no permanent history or retrieval storage is retained in the system. The service should be available to narrative/record subscribers. (This type of privacy is inherent for ADP transactions since no record of that traffic is retained in the system.)

e. Informal Message Exchange. This service allows for the exchange of informal or unofficial information among users. It is similar to narrative/record message transfer except limited network functions are provided. An abbreviated, simplified format is used and, therefore, no format conversion is provided. Message storage and retrieval functions are not provided, i.e., only intransit storage is provided. The service should be available to all IAS subscribers.

f. Mailbox Service. This service allows a user to send messages to a storage location in the network for subsequent retrieval by the addressee. Mailbox service is an augmentation to the informal message exchange service.

g. Data Teleconferencing. This service allows a conference to be conducted among network subscribers using teletypewriters, video display terminals, or similar terminal devices. Conferencing may be simultaneous (conference members exchange transactions on a real-time basis) or delayed (members enter and retrieve transactions at their own convenience). A transaction may be addressed to the

conference or to any member of the conference. A network element will control the conference, store conference transactions and respond to requests for conference data or status information from the members. The data teleconference service is an augmentation of the informal message exchange service and should be available to most subscribers.

D. Special Items. The purpose of this sub-section is to provide the status of several key action items that are an influencing factor in the evolving mid-term architecture.

1. Telecommunications Center Consolidation and Extension of Automation Program.

a. Background. A major DoD objective is the consolidation of telecommunications centers (TCC) and other message processing facilities to the maximum extent consistent with cost benefits, survivability and responsive service to the user. The major consolidation program benefit is the potential savings through decreased operating, maintenance and personnel costs. Such savings are achieved through physical consolidation of TCCs, either through integration or collocation, or through extension of automation from an AMPE. Physical consolidation involves closing a TCC and providing over-the-counter service from a remaining TCC. In this case, a single integrated facility may provide service or facilities may be collocated within the same building area. Extension of automation involves connection as a remote terminal to an AMPE. The remote terminal uses the automated capabilities of the AMPE to perform the message processing functions which would normally be done manually if the terminal were to be directly connected to the AUTODIN system. TCC consolidation and extension of automation result in decreases in the number of directly connected AUTODIN terminals. Extension of automation results in an increased demand for the I-S/A AMPE, and promotes a distributed AUTODIN architecture. The following paragraphs summarize consolidation and extension of automation progress within the DoD community.

b. Physical Consolidation. As stated in the IASA Report (Part I), the DoD telecommunications community had identified 140 locations offering sufficient potential for TCC consolidation as to warrant a detailed feasibility study. To date, 66 consolidations have been approved or completed, 26 consolidations are not feasibile, and studies

for the remaining 48 locations are in process. Almost all the 140 locations involve consolidation of a TCC processing General Service (GENSER) traffic with a TCC processing Defense Special Security Communications System (DSSCS) traffic. In general, those actions found feasible require closing of the DSSCS TCC, with over-the-counter service provided from the GENSER TCC. Although such actions usually reduce the total number of TCC personnel required, the total number of personnel needing access to Sensitive Compartmented Information (SCI) is generally increased. The Director, Central Intelligence, however, placed a moratorium on new SCI billets in June 1977. As a result, ASD/C^3I requested a waiver to the moratorium to allow continuation of new programs through December 1979, and has recently received approval to permit the TCC R/Y consolidation program to proceed.

c. Extension of Automation. JCS Memorandum of Policy 165 limits extension of automation by restricting the distance between a remote terminal and its servicing AMPE to 25 miles. Any proposed connection exceeding the 25 mile limitation must be coordinated with DCA and approved by OJCS on a case-by-case basis. This procedure is a safeguard against establishment of dedicated networks vice use of the common user networks. In the short term it restricts extension of automation with fielding of the I-S/A AMPEs, the distance limitation of 25 miles will be reassessed as DCA has overall program management control.

(1) In a effort to ensure the individual Service/Agency programs were not providing redundant AMPE systems serving a single geographic location, OJCS initiated two actions. The first tasked CINCPAC and CINCEUR to review geographic areas of responsibility. These reviews have been completed. CINCEUR determined no unnecessary AMPE installations were installed or planned CINCPAC arrived at the same conclusion, with one exception - the CINCPAC review recommended a study of the feasibility of consolidating Makalapa and Camp Smith LDMX installations on Oahu. OJCS subsequently tasked CINCPAC to conduct the recommended study, which is now underway. A consolidated system on Oahu is viewed as a potential candidate for installation of the I-S/A AMPE.

(2) The second OJCS initiative is in process. It involves approximately 25 locations within the CONUS,

each of which is assigned to a Service/Agency, generally with the greatest local interest. Services/Agencies will study the feasibility of extending automation from a local AMPE to all DoD TCCs within the local area. Completion of all studies is anticipated by January 1980. The results will be factored into the I-S/A AMPE acquisition program.

d. DSSCS/GENSER Accreditation. In January 1978, ASD/C^3I released a manual providing security criteria and telecommunications guidance for the protection of Special Intelligence stored and/or processed in a consolidated DSSCS/GENSER Automated Message Processing System. Prior to its use for DSSCS traffic, any automated system, such as the AMPE, must be accredited by NSA or DIA, as appropriate. The manual governs automated systems without connected remote terminals, those with only DSSCS connected remote terminals, and those with one or more GENSER-only remote terminals. The intensity of the security risk is greatest for systems with GENSER-only connected remote terminals. Accordingly, the criteria are applied most rigorously to such cases.

(1) Within the separate Service/Agency AMPE programs, only the NSA STREAMLINER has been granted DSSCS accreditation. The STREAMLINER has not, however, been accredited to accept both DSSCS and GENSER remote terminals. The results of an NSA feasibility study indicate such accreditation would not be cost effective. Navy is attempting to obtain DSSCS/ GENSER certification for its London LDMX facility; however, accreditation for GENSER-only remote terminals will only be sought after successful accreditation in a "system-high" environment. At this time, Navy does not plan to seek accreditation for the NAVCOMPARS AMPE. Air Force and Army are coordinating with NSA to obtain accreditation for, respectively, the AFAMPE and AMME systems.

(2) It is essential that the I-S/A AMPE be accredited to service simultaneously both DSSCS and GENSER remote terminals; otherwise, local geographic areas will continue to require separate DSSCS and GENSER AMPE facilities. Accordingly, development of the I-S/A AMPE will be conducted in close coordination with NSA, to ensure the system architecture is compatible with DSSCS/GENSER accreditation.

2. Automated Message Handling Systems (AMHS). This section provides a brief summary of AMHS program background, and contains an assessment of DoD AMHS program direction and its potential impact to the IASA project.

a. AMHS Definition. Automated Message Handling Systems (AMHS) are computer based systems consisting of one or more processors and associated terminals which collectively automate the receipt, distribution, storage, retrieval, preparation, review, or transmission of narrative pattern message traffic. They are typically used to automate communications center functions as well as end user message handling tasks, particularly in the high volume environments associated with command and intelligence watch centers. The definition excludes data processing systems that receive messages as part of the data base updating process. The term, in particular, includes such automated telecommunications oriented systems as the Automated Message Processing Exchange (AMPE), command and control oriented systems such as the National Military Command Center (NMCC) Information and Display System (NIDS), and intelligence oriented systems such as the National Military Intelligence Center Support Subsystem (NMIC-SS). The telecommunications oriented systems primarily aid the communicator, i.e., they automate tasks which would otherwise be accomplished manually by communications personnel. The command and control and intelligence systems are categorized as user oriented systems, i.e., they primarily aid the writer/reader by automating tasks associated, e.g., with message composition, data base search, etc. Such systems would typically be used by intelligence center analysts and command center personnel.

b. Background.

(1) On 25 March 1977, the Surveys and Investigations Staff of the House Appropriations Committee (HAC) published a report highly critical of DoD management in the development of AMHS, citing lack of standardization and duplication of effort. The subsequent HAC report to the House on the FY 1978 DoD Appropriations Bill recommended cuts in several AMHS programs, and levied the following criticisms/comments:

(a) There were thirteen, possibly more, different AMHS systems under development.

(b) There appeared to be unnecessary duplication in their development.

(c) AMHS were not always needed or designed to meet the real needs of the commander.

(d) Users were not given a hand in system development, and consequently did not fully understand or use the developed system.

(e) Future DoD budget requests must include provisions for commonality and interservice use of hardware and software.

(2) In mid November 1977, ASD/C3I tasked DCA to lead a Service/Agency review assessing the HAC criticisms and recommending an overall DoD AMHS program direction. The subsequent report was forwarded through OJCS to ASD/C3I in January 1978. It concluded that:

(a) Functional standardization and operational validation of telecommunications oriented AMHS are being adequately addressed within the IASA project.

(b) Functional standardization and operational validation of the command and control and intelligence information oriented AMHS are not being comprehensively addressed within the DoD, althrough those issues are being addressed with various degrees of success within the individual communities of interest.

(3) In mid February 1978, ASD/C3I stated an intention to prepare a comprehensive AMHS master plan. To assist in plan preparation, DCA, DIA, and OJCS/WSEO were tasked to submit, respectively, reports on the telecommunications AMHS, the intelligence oriented user AMHS, and the command and control oriented user AMHS. Each report was to contain an assessment of AMHS operational reports, in toto, were to constitute an input to the comprehensive plan for AMHS development and life cycle support.

(4) The AMHS plan was formally published on 1 February 1979. It is comprehensive, identifying both near and far term actions, and it tasks DCA with the discharge of significant new AMHS responsibilities. The plan serves as the vehicle whereby Services/Agencies are informed of the DoD plan, Services/Agencies are tasked to implement the plan, and a rational and systematic AMHS management approach is delineated. The specific taskings to DCA include:

(a) Exercise of end-to-end architectural management responsibility for both telecommunications and

user oriented AMHS. The IASA project is recognized as meeting this need for the telecommunications oriented AMHS.

(b) Coordination of DoD AMHS research and development activities.

(c) Development of the IASA and I-S/A AMPE program.

(d) Formation of a joint DCA/DIA program office for the near-term implementation, configuration control, and software support of a NMICSS derivation system for the AMH portion of the NIDS.

(e) Assumption of management responsibility for system development and life cycle support of interservice common, fixed base AMHS.

(f) Development of a compact version of NMIC-SS and its implementation to meet validated WWMCCS requirements.

(g) Development and coordination of a near term plan for implementation and support of the standard user-oriented AMH system, and a long-range architectural plan for the evolution of AMH systems in general. These plans are to be submitted to OSD for approval by 30 September 1979 and 31 July 1981, respectively.

(h) Submittal, within sixty days of AMHS plan publication, detailed resource alternatives for the DCA assumption of these AMHS management responsibilities.

(5) DCA is now developing the detailed resource alternatives mentioned above, with input to ASD/C^{3}I by April 1979.

c. Program Direction. The goals and objectives delineated in the AMHS plan, when taken in conjunction with the set of specifically assigned tasks, constitute a baseline for the following projection of an "ideal" (i.e., meeting the stated objectives) standard AMHS configuration for the mid to late 1980s. At the base, post, camp, station or activity level, AMHS would be integrated into a single highly modular consolidated facility. This would include command and control, intelligence, and telcommunications

AMHS, each of which might be viewed as constituting a major subsystem. This system would be capable of multilevel secure operation with all applications software programmed in a common high order language. Further, the system would be able to terminate special circuits and be able to interface with ADP systems, including the WWMCCS Information System and DoD Intelligence Information System processors. The system would be fielded in the mid-1980s. Functional identity of the three subsystems would ideally, but not necessarily, consist of the same hardware. The intelligence and command and control AMHS subsystems would use a single standard system. The user AMHS standard system would also satisfy the AMHS requirements of other functional communities. Any one of a number of local architectural arrangements could meet the objectives. One such local architecture would consist of three mini-computer clusters, each serving a functional community and integrated by some mechanism, such as a common bus.

d. Impact to the IASA Project. The plan considers the IASA project to be the vehicle whereby telecommunications AMHS objectives are achieved. In this regard, current IASA planning is viewed as a sound evolutionary approach. Accordingly, the impact to the IASA project in the near-term should be negligible. In the mid and far-term, the impact may be substantial, in at least two ways.

(1) The AMHS plan envisions an AMHS architecture on an end-to-end basis, i.e., terminal-to-user AMHS to-telecommunications AMHS-to-network-to telecommunications AMHS, etc, as a continuum. It will be necessary to analyze the end-to-end system architecture to determine where functions should be allocated. For example, both telecommunications and user AMHS generally possess "delivery determination" software. Where such systems are collocated, it may be possible to achieve operational and economic efficiencies by providing the function from a single subsystem. Previously, the user and telecommunications AMHS have been designed as stand-alone systems, with an interconnecting communications interface.

(2) The second potential area of impact to the IASA project relates to user AMHS functions. The plan tasks DCA to address inclusion of certain user AMHS functions, meeting the needs of functional communities other than command and control and intelligence, within the IASA project.

The I-S/A AMPE program development should provide sufficient flexibility to assure eventual introduction of user AMHS modules where required.

3. ARPANET Connectivity to AUTODIN II.

a. General. The ARPANET connectivity to AUTODIN II was a special item in the previous IASA Report, and the subject is herein updated to reflect current status. The ARPANET provides operational, common user, data communications service, and is also used for packet switching R&D to demonstrate advances in data communications technology. DARPA and DCEC have stated a continuing R&D requirement through mid to late 1980s. There is also a User-Server Intercommunications requirement among all of its users, including military users, non military users and servers and particularly to DARPA sponsored servers at universities and corporations. The connectivity to AUTODIN II should provide continuing intercommunication for these users.

b. Alternatives. Four alternatives have been identified for the ARPANET users to connect to AUTODIN II. In summary, they are:

(1) Alternative I. Continue ARPANET operation; qualified users selected to transition to AUTODIN II.

(2) Alternative II. All non R&D DoD users transition to AUTODIN II, with residual ARPANET for R&D users; require security certifiable gateway between networks. There are three options in this alternative, involving different network front-ends, software and costs.

Option 1. Hosts transferring to AUTODIN II would reprogram their front-ends to meet AUTODIN II protocols.

Option 2. Hosts would use modified MCCU programmed to accept ARPANET messages and translate addresses to AUTODIN II logical addresses.

Option 3. Non R&D ARPANET nodes would be reprogrammed with SIP protocols; the nodes would effectively act as host/terminal concentrators.

(3) Alternative III. Use of a Value Added Network (VAN) for both R&D and non R&D users.

(4) Alternative IV. Use of a VAN for non R&D users, while maintaining residual R&D ARPANET.

c. Analysis.

(1) Alternative I maintains status quo for R&D users, preserves user-server relationships, and is the lowest cost alternative. Although Honeywell based equipment is no longer supported by the vendor, adequate maintenance from current contractor is expected for at least five years. Expansion of the network is limited by available equipment alternatives.

(2) Alternative II has the 3 options which partially satisfy the OSD intent that DoD ADP system users transition to AUTODIN II, but would require a change to current AUTODIN access policy to permit non-DoD/non-Government user access. Options 1 and 3 have major impact on host software. This alternative also has the highest transition costs of all alternatives.

(3) Alternative III uses a VAN with gateways, and represents the next to lowest cost of the three alternatives. It has an earlier implementation period than the Alternative II options, 1980 versus 1982, but it will not support the overseas ARPANET requirements. It is the only option in which ARPANET nodes are completely removed.

(4) Alternative IV uses both a VAN and a gateway to the residual R&D ARPANET. It has the same implementation period as Alternative III, but has higher transition costs than Alternatives I and III. Similar to Alternative III, it does not satisfy the OSD intent to transition DoD ARPANET users to AUTODIN II.

d. Approach. DCA should continue to operate the ARPANET under the Alternative I approach, with qualified military users transferred to AUTODIN II in 1981. DCA and DARPA should continue the development of gateways between the ARPANET and the AUTODIN II. DARPA estimates that these gateways should be available by 1981. When both the AUTODIN II and the gateways are operational, DCA and ARPANET sponsors should identify the most cost effective network connectivity to satisfy existing and future requirements.

4. Billing Structure.

a. The Assistant Secretary of Defense (Comptroller) has approved continuation of the present method of billing AUTODIN customers through FY 1980. This is a single subscriber rate schedule for all categories of service offered by the AUTODIN network and is based on connectivity and the baud rate of the access lines. Subscriber rates are published semi-annually by the DCA Comptroller's office.

b. The monthly backbone rate charged AUTODIN customers is used to pay for the cost of AUTODIN leased switches, operation and maintenance of switching centers, interswitch trunks, interconnects into AUTOVON and seventy percent of the channel control units interface software.

c. For FY 1981, DCA is studying the merits of expanding the coverage of the backbone to also include costs associated with service facilities such as AMPEs, subscriber access lines, modems, multiplexers, concentrators, interface development to include software design and development, and leased hardware costs. In essence, consideration is being given to including all costs of the system with the exception of equipment procured by the government and terminal equipment funded by the customers.

5. Standards. To realize both economy and interoperability, IASA design requires broad range standardization where practicable. This standardization includes the communications procedures, protocols, interfaces, modes, formats, message handling, security and privacy, as well as needed staffing standards for AUTODIN system elements. These standards are needed to provide the design criteria, the development structure, and the implementation scheme for the future AUTODIN communication system. The IASA goal to design and engineer a system on a terminal to terminal basis, complete and integrated from end to end, will not only reduce design inefficiencies and implementation costs, but will also enhance interoperability with present and future systems. In response to ASD/C3I tasking, standards in these and other areas are being identified, developed, and promulgated. The following is a summary of major standardization efforts:

a. DD Form 173 Standardization.

(1) A study was made of the present DD Form 173 Joint Messageform and discovered that each MILDEP had made deviations to the standard form provided in MIL-STD-188c.

The study also revealed that each MILDEP, and in most cases local requirements, dictated the preparation of the form to meet local optical character reader (OCR) equipment software and hardware requirements.

(2) To provide a DoD standard form the three forms were compared and a revision developed to include additional information and new requirements such as providing for the Special Category designators. At the same time a standard procedure for the completion of the form was developed. The MCEB has approved the revised form and instructions have been promulgated in a printed change to ACP 121. Distribution of this change was completed during January 1979 with mandatory implementation of the revision on 1 January 1980.

b. Plain Language Address Directory.

(1) The development of a standard Plain Language Address Directory (PLAD) for record telecommunications has been needed for some time. With the introduction of OCRs, the use of computers to provide PLA/Routing Indicator look-up, consolidation of telecommunications centers, and the use of AMPEs, the need for having a standard unique identification for a specific organization, DoD-wide, is imperative.

(2) The MCEB in 1976 directed that a Joint PLAD be developed to include all DoD activities not listed in Service publications and all other activities that use DoD communications facilities. In March 1977 a draft Joint DoD PLAD was distributed to Unified and Specified Commands, MILDEPs, and DoD Agencies for evaluation and comments. Comments were forwarded to the MCEB to determine the usefulness of the Joint PLAD. Based on inputs received, the MCEB issued a directive in September 1978 for the development of a Joint DoD PLAD.

(3) The Call Signs Panel of the MCEB is determining the scope, format, content, update maintenance, and distribution of a Joint DoD PLAD. Except for printing and distribution, development of a Joint DoD PLAD should be completed by July 1979.

c. Automated Message Distribution System.

(1) For several years the MCEB has been attempting to develop a standard message delivery system. In June 1975, Ketron, Inc., studied the problem and provided recommended

methods for an automated message distribution system. The study was reviewed by the MCEB, and a briefing given to the Service/Agency principals in June 1976. It was recommended that the study be forwarded to the JCS for review and comments by Services/Agencies administrative staffs. Subsequently, JCS forwarded the Ketron study to the Services and Agencies for comments and recommendations. After receipt of the comments a joint action was opened in April 1977 to respond to the MCEB. JCS response, provided the MCEB in October 1978, did not agree with the Ketron study recommendation to use a subject index coding system, but rather recommended that a standard should be developed which capitalizes on automated message processing capabilities that will minimize the burden on both the message writer and recipient.

(2) The MCEB has appointed DCA as lead agent to develop a standard Automated Message Distribution System. Action on this item should be completed by October 1979.

d. Staffing Standards.

(1) The automation of operational functions in telecommunications centers has focused attention on the need to revise the present DoD staffing standard for manual and semi-automated telecommunications centers. In December 1977, joint Service/Agency ad hoc working groups were appointed under the IASA project charter, to develop staffing standards for telecommunications facilities (manual/semiautomated TCCs, ASCs, and AMPEs).

(2) The first working group was tasked to develop a staffing standard for manual and semi-automated telecommunications centers. Their report was submitted to DCA in September 1978. After review by the IASA Technical/Policy Panel a draft DOD Instruction was forwarded to ASD/C3I in November 1978 for approval and implementation.

(3) The second working group was tasked to develop a staffing standard for ASCs. Their report is under review at DCA and a draft DoD Instruction should be forwarded to ASD/C3I by June 1979.

(4) A third working group was tasked to develop a staffing standard for AMPEs. This group should provide a report to DCA by December 1979.

e. Privacy Considerations.

In AUTODIN I, the AUTODIN Limited Privacy System (ALPS) provides the required level of privacy by not recording traffic on history tapes within the ASC. AUTODIN II will also support access restrictions to a community-of-interest based upon Transmission Control Code (TCC) designators.

(1) TCCs are not intended to replace existing ADP system controls, such as passwords or file names. Each TCC is a unique and separate code not dependent on or related to the security classification. Network access requires that all subscribers be assigned a TCC. Any subscriber not identifying a TCC requirement will be assigned a common user network TCC and will become a member of the common user network community.

(2) A TCC will be identified in each packet of data. Each packet entering or leaving a packet switch by an access circuit will be validated as belonging to the closed subscriber group having access to that circuit. A TCC mismatch (attempted delivery/connection to a subscriber not authorized that TCC) will be handled the same as a security mismatch. The network will automatically generate a service message to the subscriber for an invalid TCC field, and a report will be made to the packet switch operator and the Network Control Center's (NCC) controller. The NCC controller and packet switch operator will follow procedures that ensure the mismatch is recorded and reported to their security representative. Release of TCC designators will be limited to the subscriber group to whom the TCCs are assigned.

f. High Order Language. While the design goal of maintaining flexibility means that software cannot be completely standardized, some standardization can be provided through a high level, machine independent, telecommunications oriented computer language. DARPA, through a DoD contract, is developing Ada, which is a high order software language to support the special needs of embedded computer applications such as AUTODIN II. By 1981 there should be sufficient information to decide whether Ada is a viable common high order software language. Plans are to recode the I-S/A AMPE software in this high order language with implementation by 1985.

6. <u>WIN Integration into AUTODIN II</u>.

a. Background. This subject was a special item in the IASA Report (Part 1) and is herein updated. On 7 March 1978, ASD/C3I approved the WWMCCS Intercomputer Network

(WIN) Implementation Plan, directed that the WIN be fully integrated into the AUTODIN II by December 1980, and requested that an integration plan be forwarded to OSD by 31 August 1978. On 1 April 1978, the Prototype WIN (PWIN) was re-designated as the WIN. In December 1978, the JCS distributed a draft plan for the transition of the WIN to AUTODIN II. The plan includes prerequisites for cutover, discussion of the Network Front End (NFE) approach and a cutover schedule of the WIN to AUTODIN II.

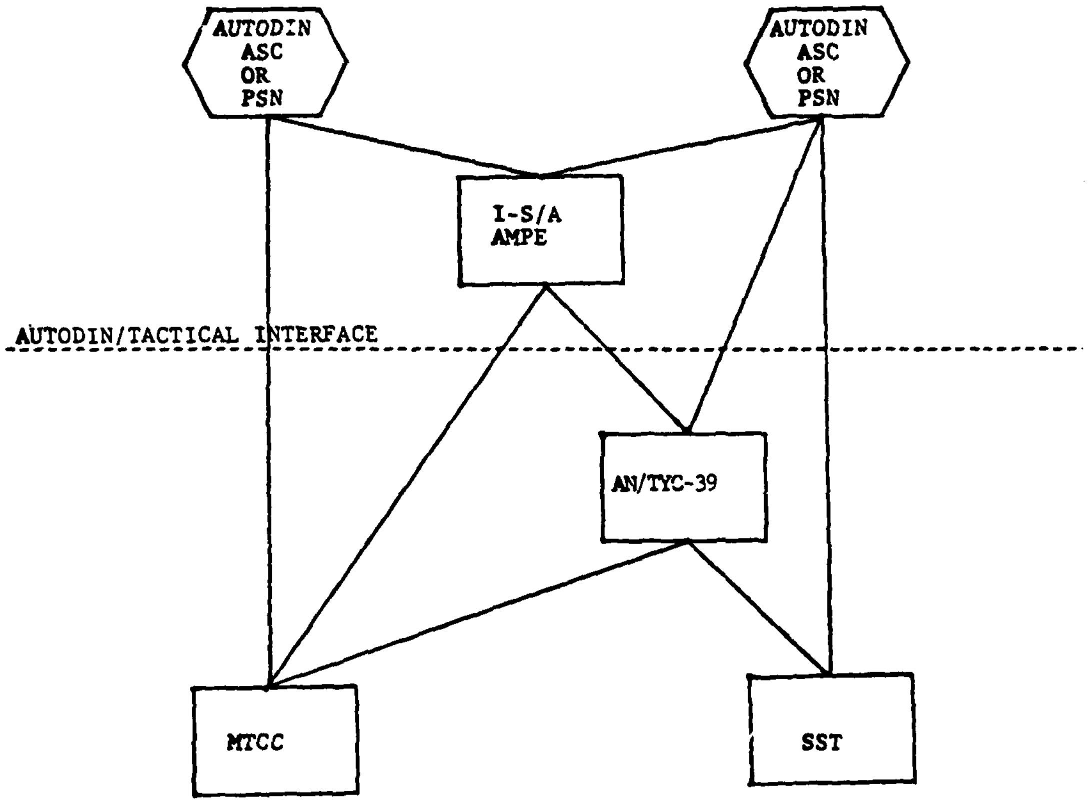
b. Requirements. Five WIN requirements of AUTODIN II, listed as prerequisites prior to integration, are: 1) AUTODIN II will be available for WWMCCS use by April 1980; 2) stable AUTODIN II system performance, including accreditation to a security level of at least TOP SECRET; 3) operational network front-end to be available by July 1980; 4) equipment for the NFE to be acquired under Air Force contract from standard WWMCCS equipment; 5) operational AUTODIN II PSNs at five CONUS locations prior to final cutover of WWMCCS computers to AUTODIN II.

c. Approach. By ASD/C^3I direction, the WIN should should transition to AUTODIN II by December 1980. Based upon the transition issues to be resolved, it is unlikely that the cutover date of December 1980 can be met, and the October 1981 date presented in the JCS plan is more realistic.

7. Tactical Systems Interface to AUTODIN. By TRI-TAC Program definition, tactical systems will be interoperable with current and planned DCS networks. The general mode of circuit verfication and system control between the DCS and tactical systems will initially be manual, with a goal of increasing automation between control elements on a cost-effective basis.

a. Interface Elements. The TRI-TAC System Architecture describes two facilities as interfacing with AUTODIN: (1) the AN/TYC-39 Store and Forward Module; and (2) the Modular Tactical Communication Center (MTCC). The tactical systems interfacing to AUTODIN are illustrated at Figure 9.

b. AN/TYC-39 Store and Forward Module. The AN/TYC-39 will be evaluated as a potential I-S/A AMPE candidate, but it is expected to require significant upgrading to include AMPE functional capabilities. The AN/TYC-39 will be delivered during FY 1982 and its availability should coincide with the deployment and retention schedule of the Inter-Service/Agency AMPE. Access to the AUTODIN should, as a minimum, be the Mode I protocol.



TACTICAL SYSTEMS/AUTODIN INTERFACE

FIGURE 9

c. MRTT. The MRTT is a family of terminals, presently including the Modular Tactical Communications Center (MTCC) and the Single Subscriber Terminal (STT). Both terminals should provide access to the AUTODIN using the Mode I protocol.

(1) MTCC. The MTCC will be a tactical communications center including processor/controller, auxiliary storage, COMSEC interface, and combinations of Unit Level Message Switch (ULMS), SST, OCRs and other peripherals. Access to the AUTODIN should be in Mode I protocol.

(2) SST. The SST provides access to the AUTODIN in selectable Modes I, II, or V. The SST can have variable configurations, but the primary configuration is a keyboard/display terminal with auxiliary memory. It should be deployed at the tactical unit level or as part of the MTCC.

8. Survivability.

a. General. The mid-term architecture should be designed to function effectively during peacetime and non-peacetime conditions ranging from localized crises situations to worldwide disruptions. To create this degree of reliability, the mid-term architecture should reflect a robust telecommunications system, capable of supporting continued command and control operations. Interoperability with the US Allies is a prerequisite for establishing a flexible and survivable system overseas. Specific RDT&E attention has been given to increasing the ability of the DCS to meet system survivability requirements and to provide the capability of rapidly reconfiguring the system to meet changing military requirements; to correct deficiencies that exist in digital transmission facilities and interactive data transfer capability; and to increase the ability to handle computer-to-computer data traffic.

b. Approach. A major design criteria in the mid-term AUTODIN architectural work has been to enhance survivability of network elements in the evolutionary development of the IAS. The mid-term architecture moves switch functions closer to the user by use of the I-S/A AMPE. This approach, in consonance with recent planning efforts for DCS architectures, will reduce the dependency on the more vulnerable backbone switches and should enhance overall survivability. For instance, although economics have driven previous decisions to collocate AUTODIN I switching centers with AUTODIN II packet switching nodes, the need to enhance survivability of these network elements is under evaluation to determine

future siting of these facilities. Several development areas associated with achieving enhanced IAS survivability include: (1) conventional hardening of key nodes/sites; (2) design of new facilities with improved physical and electromagnetic pulse survivability; (3) interoperability and mutual support agreements with other networks; (4) transmission diversity and redundancy; and (5) use of TRI-TAC, foreign national and other allied military communications for AUTODIN system augmentation and restoral.

9. <u>NATO Interface to AUTODIN</u>.

a. In the IAS mid-term, interface between US and NATO will be through the NATO Integrated Communications Systems/Telegraph Automatic Relay Equipment (NICS/TARE). The NICS/ TARE will be an enhancement of the former Telegraph Automated Relay Equipment (TARE) system. The automated NICS/TARE system will connect directly to AUTODIN I ASCs via Allied Relay Stations.

b. The formats, protocols and AUTODIN nodes used in the interface are based upon US/NATO agreements, and have been factored into the IASA mid-term design. The interface between AUTODIN I and the NICS/TARE will be a modified Mode I terminal interface to provide the basic access interface protocol. Although this interface is not considered optimal for the eventual integrated system operation, it is not considered feasible in the near-term to accomplish significant protocol/interface modifications. Implementation of new access arrangements for NATO users of the AUTODIN should be accomplished in the mid-term.

SECTION III

SECTION III

SYSTEM ARCHITECTURE (1984-1988)

A. General. The purpose of this section is to provide mid-term (1984-1988) AUTODIN system architecture alternatives and recommendations for major network elements to include packet switching nodes, access area exchanges and terminals.

The IAS Architecture is a system-level description which considers all the user motivated functions (e.g., plain language addressing) and system-motivated functions (e.g., routing) required for end-to-end data communications and teleprocessing services, allocates these functions to a feasible subset of the set of all possible elements (e.g., nodes, multiplexers, terminals, etc), partitions the elements into levels (i.e., backbone, local and regional access area), specifies the transmission media and connectivity policy for interconnecting the various elements and network levels, and describes the method of system operation. In doing so, hardware and software features are included, and the way in which the elements are interconnected into a network topological structure are specified. Protocols, interfaces, routing methods, and other operational and control procedures which determine how the interconnection and operation of elements provide the required service to the user are stipulated.

The IAS Architecture is comprehensive enough to allow the development of requisite functional specifications and to allow for meaningful costing at the system level. For those elements which already exist or are already designed, engineering and software documentation or specifications and planning documents are incorporated into the architectural description. For new elements, functional specifications will be developed to complete the description.

The IAS Architecture establishes the necessary elements for the orderly growth of DoD data communications, and should provide decision makers with the requisite criteria, in terms of planning and costing data, to make accurate, timely and meaningful decisions. Decisions predicated on the IAS Architecture will be founded upon a total terminal-to-terminal system design, eliminating functional duplication and enabling a cost-effective approach to the acquisition of needed communications capability. The approved IAS Architecture should be the basis from which the detail design can begin. Designers will use the IAS Architecture as technical

and policy guidance to prepare development plans for obtaining the hardware and software needed to advance from the near-term (1978-1983) architecture to the mid-term (1984-1988) architecture.

B. The Mid-Term IAS Architecture. In the mid-term the architecture should provide many value-added capabilities to the user which require a large measure of data processing power within the network. Two basic architecture approaches that can provide this processing power are to centralize processing in a small number of network nodes and use high performance computers or to distribute processing power throughout the network. The process of defining a centralized or distributed mid-term architecture is constrained to consider only those architectural alternatives which are technically and economically feasible. The architecture alternatives described in the succeeding paragraphs are consistent with the objectives and the evolutionary approach of the IASA project.

C. Architecture Alternatives. In order to insure that all potential mid-term architectures were considered, a number of architectures were identified as part of the technical analyses performed in support of the IAS architecture definition. These architectures were generated through a sequential decision tree approach based on three major architectural decision levels:

- Selection of an element set from among the available candidate elements discussed in Section II.

- Allocation of functions among the selected element set.

- Consideration of specific configuration/connectivity options within the architecture (e.g., dual/single homing of nodal elements).

This definition process resulted in the identification of 23 architectures. Upon analysis of the characteristics of the architectures, it was determined that these architectures could be organized into three major classes. Further, it was determined that within each major class the differences between architectures were not sufficient to significantly impact the potential cost and/or performance of the resultant system architecture. Therefore, three final architectures were selected for evaluation by choosing the most representative and/or desirable from within each major class. These three final alternative architectures are described in the

following sub-sections. These three architectural alternatives use the packet switched node (PSN) as the principal backbone switching element and the Inter-Service/Agency AMPE (I-S/A AMPE) as the principal access area message processing and communications concentration element. In addition, all three alternate architectures should provide the required IAS user network services and functions defined in Section II.

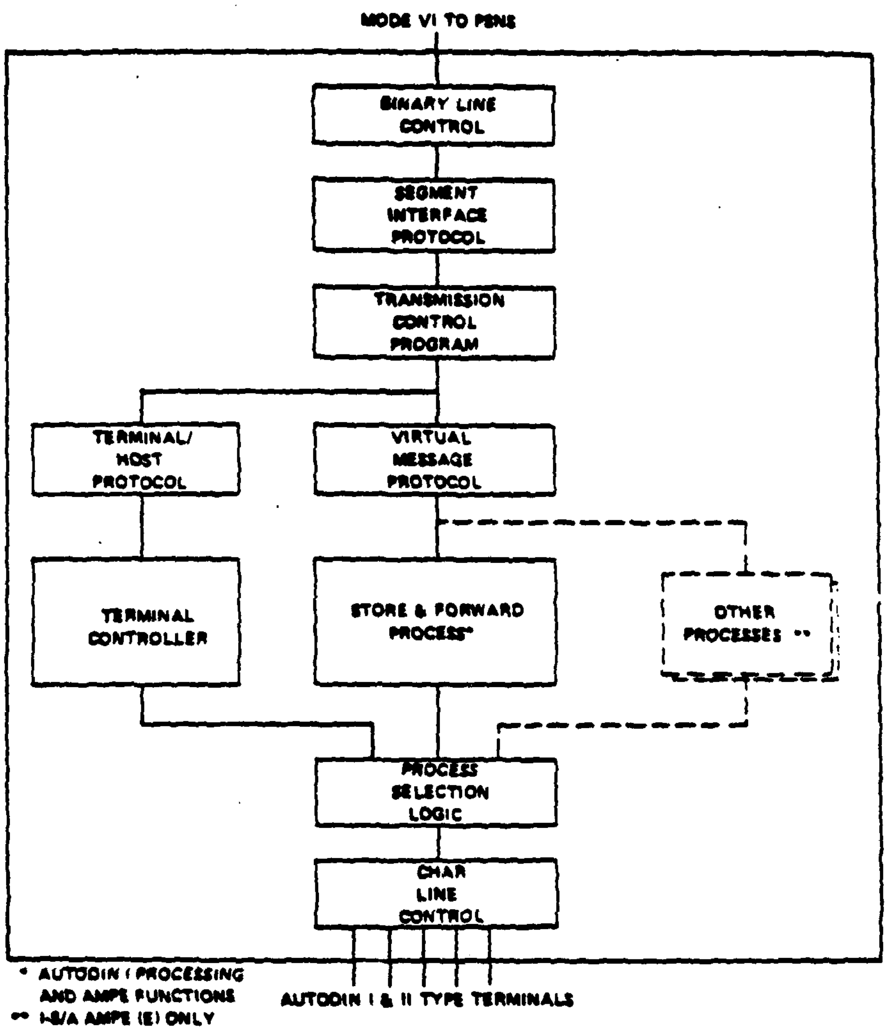
1. Alternative I.

a. General. This alternative presents a centralized architecture with little or no hierarchical structure in the access area. All network and user services in this alternative are provided from a small number of service elements connected to the backbone and accessed via the network.

b. Elements. The major elements of this architecture are the PSN, I-S/A AMPE, CSF and subscriber terminals. These elements and their application/role in the architecture are discussed in the following sub-paragraphs.

(1) Packet-Switching Node (PSN). The mid-term architecture will use the PSN (described in Section II.B.1.b) as the backbone switching element for the mid-term IAS. The AUTODIN II PSN will not require any anticipated modifications to fill this role. The security subsystem (access control and key variable distribution) can be implemented in a separate host computer connected to the PSN via the network for ease of transition. (See Appendix 4) The PSN of the mid-term architecture will continue to require the TAC capability to terminate character oriented subscribers. In addition, the ability of the PSN to terminate AUTODIN I, Mode I subscribers through use of a predefined segment leader will be retained in the mid-term. No changes are anticipated to the normal routing procedures implemented in the PSN. New contingency routing schemes will be accomplished in the preferred architecture within other network elements such as the I-S/A AMPE.

(2) Inter-Service/Agency AMPE (I-S/A AMPE). The I-S/A AMPE is used in the mid-term architecture as both a local message processing service element and a limited communications network front-end. A simplified block diagram of the I-S/A AMPE is illustrated in Figure 10. As indicated, the I-S/A AMPE will include the same Segment Interface Protocols (SIP) and Transmission Control Protocol (TCP) functions contained in a PSN TAC and will function as a



INTER-SERVICE/AGENCY AMPE
FIGURE 10

remote TAC to the PSN. In addition, the I-S/A AMPE will include THP and terminal control functions needed to provide AUTODIN I service for AUTODIN II character-oriented subscribers, all functions necessary to act as an AMPE replacement, and store-and-forward processing functions needed to interface AUTODIN I terminals. In addition to terminating both AUTODIN I and AUTODIN II type subscribers, the I-S/A AMPE will provide the terminal support functions (PLA/RI conversion, format validation, etc.) needed to support user terminals that require such services.

(a) In its role as a limited network front end, the I-S/A AMPE will incorporate network protocols and processing capabilities that will permit most simple direct terminal-to-terminal/host transactions to take place without the involvement of other higher level service elements except the PSN switches. As a result of this capability, the I-S/A AMPEs will significantly contribute to more efficient use of backbone facilities and improve survivability. Further, the I-S/A AMPE will forward traffic from subscribers requiring higher level service to the appropriate network CSF. However, unlike the current system of dedicating "home" service elements, the I-S/A AMPE will be able to forward traffic to any element in the network capable of providing the service. This capability will allow dynamic load balancing among the higher level elements in normal conditions, and provide a method of contingency recovery in the event of loss of a service element.

(b) The I-S/A AMPE will replace all current AMPEs but not on a one-for-one basis. Due to its standardized implementation/operation, the I-S/A AMPE should satisfy Service/Agency requirements. This will allow consolidation of current AMPE locations with no reduction in service.

(3) Central Service Facility (CSF). The CSF provides ASC support functions for subscribers connected to PSNs and new IAS functions for subscribers in the network. The CSF interfaces to one or more PSNs as a host computer. It does not terminate subscribers.

(4) Subscriber Terminals. As previously stated, the mid-term IAS will have to support all existing types of AUTODIN I and planned AUTODIN II terminals. It is also expected that terminals with additional capabilities will be introduced in the mid-term as part of the common family of AUTODIN terminals. Although increased capability in some terminals will not relieve the network of supporting the remainder of less capable terminals, it can reduce the processing load on the network and reduce the dependence of

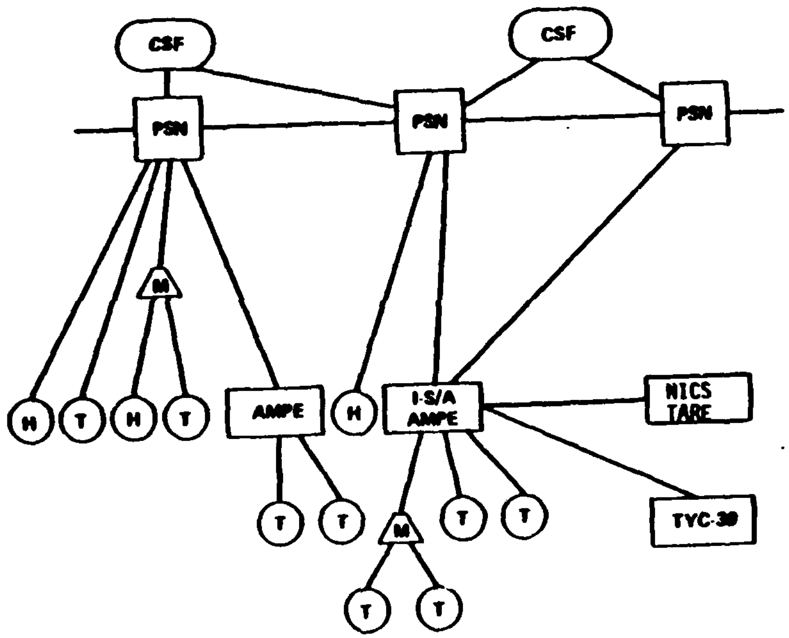
the terminals on other network elements. A summary of anticipated mid-term subscriber terminal characteristics is shown in Table 5.

c. Configuration/Connectivity. Configuration of the network elements is illustrated in Figure 11. The connection options for Alternative I are illustrated in Figure 12. AUTODIN I terminals connected to PSNs will be serviced by the CSF. The CSF connects only to PSNs and uses an AUTODIN II, Mode VI, Binary Segment Leader host interface.

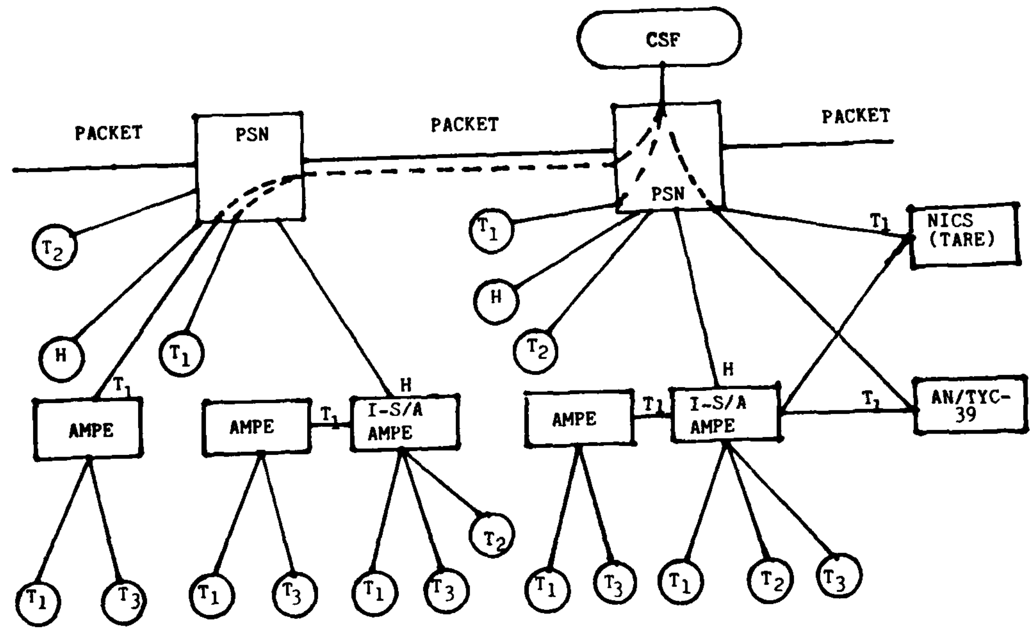
TABLE 5

MID-TERM IAS TERMINAL CHARACTERISTICS

TYPES	- All AUTODIN I and AUTODIN II types plus common family of terminals to include more intelligent/capable terminals.
PROTOCOLS	- All AUTODIN I and AUTODIN II protocols plus additional unique link protocols (e.g., AMPE user protocols) and new end-to-end protocols (e.g., Virtual Message Protocol)
CODES	- ASCII and ITA#2 (others transparent)
SPEEDS	- 45.5bps - 56K bps
FORMATS	- AUTODIN II Segment Formats, JANAP 128, ACP 126/127, DOI 103, DD-173



ALTERNATIVE I CONFIGURATION
FIGURE 11



T_1 = AUTODIN I MODE I

T_2 = AUTODIN II MODES I, IB, IIA, VI

T_3 = AUTODIN I MODE II, V OR USER UNIQUE*

H = AUTODIN II MODE VI, BSL

-------REMOTE HOMING VIA "CUT THROUGH"

*NOT ALL MODES AVAILABLE AT ALL MODES

ALTERNATIVE I CONNECTIVITY
FIGURE 12

d. Protocols. Alternative I requires the development of at least one new network level protocol. This protocol, called the Virtual Message Protocol (VMP) will support direct exchange of message information among I-S/A AMPEs via the PSN backbone. Additional network level and even link level protocols may be identified in the process of further defining the mid-term network services and operating procedures. However, these protocols will be implemented only in the IAS mid-term elements. No additional protocols are required in existing elements to support the preferred architecture. This is a significant consideration in the evolutionary development of the mid-term IAS network. The anticipated link and network level protocols and their use in this alternative are discussed further in the following sub-paragraphs.

(1) Link Protocols. The link level protocols anticipated between mid-term elements are summarized in Figure 13.

(2) Network Level Protocols. The mid-term architecture makes use of the protocol layers defined for AUTODIN II. The I-S/A AMPE will operate through the network using host-type protocols, i.e., they will employ the Segment Interface Protocol (SIP) and Transmisstion Control Program (TCP). In addition, they will use a Virtual Message Protocol (VMP) for exchanging message traffic through the packet network. The VMP will include functions necessary for routing and accountability of narrative/record traffic (most of which are presently provided by the ASCs) such as message acknowledgements, rejections, cancellations, service message generation, and message control block functions. The network level protocols required for the mid-term IAS architecture are defined in the following sub-paragraphs.

(a) Switch-to-Switch Protocols. Switch-to-Switch protocols are defined for AUTODIN II PSNs to accomplish routing, accountability and flow control between local and source/destination packet switches. These protocols are not changed by the mid-term architecture.

(b) Host-to-Switch Protocol. The protocol used between PSNs and AUTODIN II hosts and between PSNs and I-S/A AMPEs is the SIP, accomplished through the exchange of binary segment leaders.

NETWORK ELEMENTS	PSN	*** I-S/A AMPE(E)	I-S/A AMPE	AMPE	HOST	TERMINAL
PSN	VI	VI	VI	*I	VI	I, IB, IIA, VI
I-S/A AMPE(E) ***	VI	*VI	VI	I	*	**I, IB, II, IIA, V, VI, SS
I-S/A AMPE	VI	VI	*VI	I	*	**I, IB, II, IA V, VI, SS
AMPE	*I	I	I	NA	NA	**I, II, V, SS
HOST	VI	NA	*	*	NA	HS
TERMINAL	I, IB IIA, VI	**I, IB, II, IIA V, VI, SS	**I, IB, II, IIA, V, VI, SS	**I, IB, II, IIA, V, SS	NA	NA

* THESE CONNECTIONS WILL BE CONSIDERED ON A CASE-BY-CASE BASIS.
** ALL AMPES DO NOT HAVE ALL MODES.
*** TO BE ADDRESSED UNDER ALTERNATIVE II

NA – NOT APPLICABLE
I – AUTODIN I MODE I, CHARACTER SYNCHRONOUS
IB – AUTODIN II MODE IB, CHARACTER SYNCHRONOUS
II – AUTODIN I MODE II, CHARACTER ASYNCHRONOUS (UNCONTROLLED)
IIA – AUTODIN II MODE II, CHARACTER ASYNCHRONOUS
V – AUTODIN I MODE V, CHARACTER ASYNCHRONOUS (CONTROLLED)
VI – AUTODIN II MODE VI, BINARY SYNCHRONOUS
HS – HOST SPECIFIED
SS – SUBSCRIBER SPECIFIED

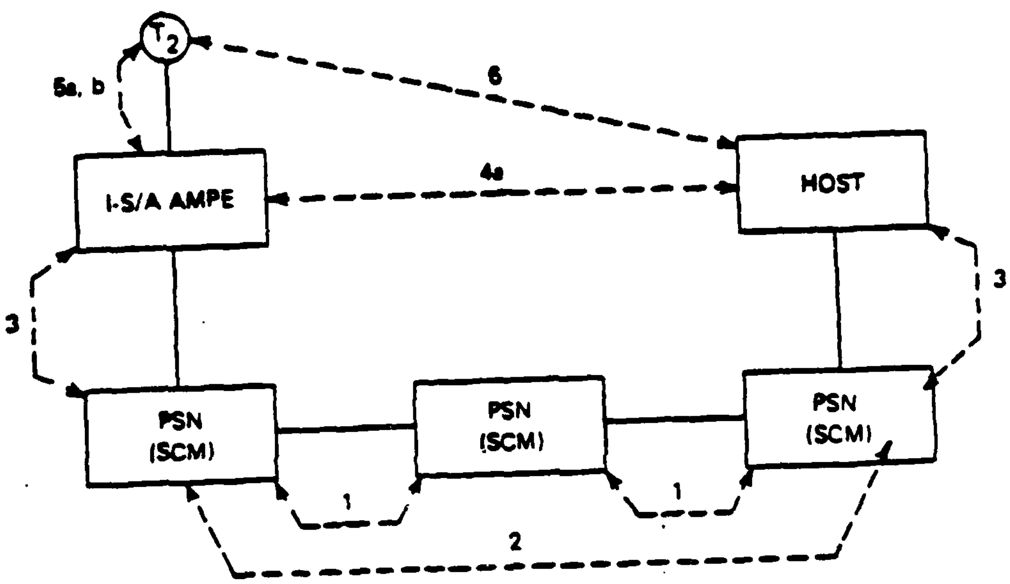
MID-TERM LINK PROTOCOLS
FIGURE 13

(c) Host-to-Host Protocols. Host-to-Host protocols refer to the general set of protocols used between host computers or automated message exchanges communicating through the network. They include the Transmission Control Protocol (TCP) and other host-specific protocols. The I-S/A AMPEs and CSF will use the TCP for communicating through the network with host computers, other I-S/A AMPEs and CSFs and part of PSN or I-S/A AMPE. In addition, the I-S/A AMPEs will use the VMP for exchanging narrative/record traffic among themselves and with other hosts of automated message processing facilities which employ the VMP.

(d) Terminal-to-Host Protocols. Terminal-to-Host protocols refer to the general set of protocols which allow terminals to interact with hosts or message processing elements. The standard AUTODIN II Terminal-to-Host Protocol (THP) will be used in the mid-term architecture for this purpose. The THP supports terminal-to-terminal and terminal-to-process transactions by making the various terminals and processes appear as similar as possible to users. These transactions require interaction between source and destination THPs and between the THPs and the terminals and host processes. In AUTODIN II, the THP is implemented in host computers and PSN TACs. Since the I-S/A AMPEs will provide a TAC capability for AUTODIN II subscribers, they will also implement the THP. The elements which directly terminate subscribers must also incorporate terminal handlers, or terminal control protocols tailored to the characteristics of the specific terminals.

(e) User-to-User Protocols. User-to-user protocols are the procedures effected between end users of the network (where the end users may be terminal/system operators or software processes) through exchange of control information and message format. The packet switch network and the protocol levels described are transparent to the user-to-user protocols. User-to-user protocol includes such functions as user interaction with host software processes and end-to-end security functions. Message format instruction for message distribution and handling by I-S/A AMPEs, CSFs AMPEs and terminals, such as transmission release codes, office symbols, flagwords or references are also considered within the class of user-to user protocols for the purposes of this protocol definition.

Figures 14 and 15 show examples of the application of the classes of protocols described above. Figure 14 shows the primary layers of protocols required for a transaction between an AUTODIN II terminal and a PSN connected host computer. (Additional protocol layers exist which are not shown in this and other diagrams, such as originating terminal to destination host and originating host to destination PSN. Also not shown are link level protocols). In this example, the TAC equivalent functions in the I-S/A AMPE provide host level protocols.

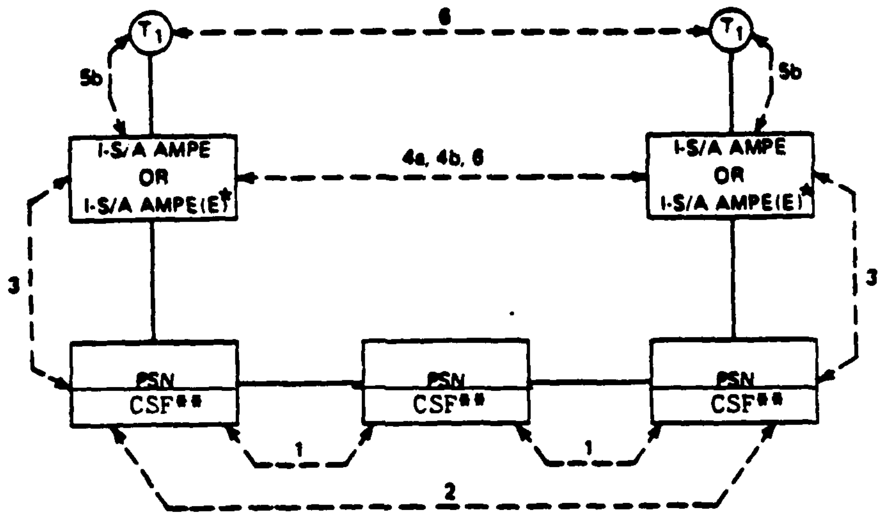


T_2 – AUTODIN II TERMINAL

1. SWITCH/SWITCH (LOCAL)
2. SOURCE SWITCH/DESTINATION
3. HOST/SWITCH (SIP)
4. HOST/HOST
   a. TCP
5. TERMINAL/HOST
   a. THP
   b. TERMINAL CONTROL
6. USER/USER

IAS NETWORK PROTOCOLS, TERMINAL/HOST TRANSACTION
FIGURE 14

Figure 15 shows the network protocols for an AUTODIN I transaction between I-S/A AMPE and CSF connected subscribers. In this case the VMP is employed between the I-S/A AMPEs and CSFs to control the exchange of narrative/record messages through the network. A user-to-user level protocol is shown between the I-S/A AMPEs and CSFs which includes message format processing such as distribution instructions. The THP used for AUTODIN II type transactions does not apply in this case.



1. SWITCH/SWITCH (LOCAL)
2. SOURCE SWITCH/DESTINATION SWITCH
3. HOST/SWITCH (SIP)
4. HOST/HOST
   a. TCP
   b. VMP
5. TERMINAL/HOST

   b. TERMINAL CONTROL
6. USER/USER

T_1 – AUTODIN I TYPE TERMINAL

*To be addressed in Alternative II
**CSFs may not be colocated with PSNs

IAS NETWORK PROTOCOLS, TERMINAL/TERMINAL TRANSACTION
FIGURE 15

e. Functional Allocation. The allocation of functions to network elements in the Alternative I architecture is summarized in Figure 16. In order to illustrate the evolutionary transition required from the near-term to the mid-term, Figure 16 includes the current near-term AUTODIN elements and illustrates their functional capabilities. As noted in Section II, the functions required for the basic AUTODIN I narrative/ record message transfer service can be generally categorized as subscriber support functions (e.g., code and format conversion, message retrieval) and network functions (e.g., multiple/collective routing). In the Alternative 1 architecture, the subscriber support functions are allocated to the I-S/A AMPE because they are most effectively performed at a point near the subscribers, and because many of these functions are already performed in the existing AMPEs. In addition, the I-S/A AMPE is also assigned the AUTODIN II terminal access functions and a Mode VI host-type interface to the PSN and the CSF both to provide flexibility for subscriber termination to the network, and to ensure an efficient, high speed, network access.

f. Operational Characteristics. The operational characteristics of Alternative I in the areas of traffic flow, security, and system control, are described in the following paragraphs.

(1) Traffic Flow. The flow of traffic through the network is described in the following subparagraphs for different types of traffic originated by subscribers connected to each of the major network elements. There are two basic types of subscribers expected in the mid-term IAS. The first type of subscriber may have terminal equipment (including AMPE) which will support only AUTODIN I operation. The second type of subscriber expected in the mid-term IAS is computer host or AUTODIN II subscriber. In the following discussion these are referred to as AUTODIN I and AUTODIN II subscribers respectively. Either type may be connected to a CSF through the PSN or to an I-S/A AMPE.

(a) AUTODIN I Subscribers. Traffic entered to an I-S/A AMPE from AUTODIN I subscribers will be formatted in an AUTODIN I format and addressed with a routing indicator (RI) or Plain Language Address (PLA). It will be automatically transferred to the store-and-forward portion of the I-S/A AMPE where AMPE and AUTODIN I functions are performed. If the message requires services not provided by the I-S/A AMPE, it will be forwarded through the PSN network to a CSF. If CSF services are not required the message will be distributed locally as necessary and/or forwarded through the PSN network

FUNCTIONS	EXISTING NEAR-TERM ELEMENTS				NEW MID TERM ELEMENTS		
	ASC	PSN	AMPE	TER-MI-NALS	I-S/A AMPE	CSF OR I-S/A AMPE (E)	TER-MI-NALS
MESSAGE SWITCHING							
HEADER VALIDATION	●		●	○	▲	▲	△
PRECEDENCE QUEUING/PRE EMPTION	●		●	○	▲	▲	△
ROUTING (SINGLE ADDRESS)	●		●	○	▲	▲	
ALTERNATE ROUTING LOCAL	●		●		▲	▲	
REMOTE (CARP)	●					▲	
MULTIPLE/COLLECTIVE MULTIPLE TRANSMISSIONS LINE	●		○			▲	
SINGLE TRANSMISSION LINE	●		●		▲	▲	
ROUTING LINE SEGREGATION	●		●		▲	▲	
TRC/SPECAT PROCESSING	●		○		▲	▲	
MCB FUNCTIONS	●				▲	▲	
PACKET SWITCHING							
LEADER/HEADER CONVERSION		●					
LEADER/HEADER VALIDATION		●		○	▲	▲	△
ROUTING		●					
CONCENTRATION (MULTIPLE ENTRY)				○	▲	▲	△
ADAPTIVE ROUTING		●					
PRECEDENCE QUEUING		●		○	▲	▲	△
LOOPING CONTROL		●					
COLLECTION/DISTRIBUTION							
DISTRIBUTION BY LOGICAL ADDRESS					▲	▲	*
PLA			●	○	▲	▲	△
FORMAT ELEMENT (SUBJECT, AIG, ETC.)			●	○	▲	▲	△
CONTENT ADDRESSING			●		▲	▲	*
FORMAT PROCESSING							
JANAP - 128	●		●	○	▲	▲	△
ACP - 127	●		●	○	▲	▲	△
ACP - 126	●		○	○	▲	▲	△
DOI - 103	●		○	○	▲	▲	△
DD - 173			○	○	▲	▲	△
CONVERSION FUNCTIONS							
MESSAGE FORMAT JANAP 128 ACP 127	●		○	○	▲	▲	△
DD 173/JANAP 128, 127			●	○	▲	▲	△
MEDIA FORMAT (CARD, TAPE, ETC.)	●		●	○	▲	▲	△
PLA RI LOGICAL ADDRESS	○				▲	▲	*
PLA RI			●	○	▲	▲	△
SPEED	●		●		▲	▲	
CODE	●		●	○	▲	▲	△
PROTOCOLS							
HOST TO NODE	●	●		○	▲	▲	△
NODE TO NODE		●					
HOST TO HOST	●			○	▲	▲	△
LINK - AUTODIN I MODE I	●	●	●	○	▲	▲	△
II	●		●	○	▲	▲	△
V	●		○	○	▲	▲	△
AUTODIN II MODE I		●		○	▲	▲	△
IB		●		○	▲	▲	△
IIA		●		○	▲	▲	△
VI	●	●		○	▲	▲	△
AMPE UNIQUE			●	○	▲	▲	
MESSAGE/FILE STORAGE & RETRIEVAL							
STORE OFF LINE FOR RETRIEVAL	●		●	○	▲	▲	△
STORE ON LINE FOR RETRIEVAL	●		●	○	▲	▲	△
INTERCEPT STORAGE	●		●		▲	▲	
EDIT MESSAGES ON FILE			○	○	▲	▲	△
READDRESS MESSAGES ON FILE			○	○	▲	▲	△
STORE STANDARD FORMS			○	○	▲	▲	△
MESSAGE FILE ACCESS CONTROL	●		●	○	▲	▲	△
RETRIEVE BY MESSAGE ID	●		●	○	▲	▲	△
ADDRESSES	●		●	○	▲	▲	△
TIME OF RECEIPT	●		●	○	▲	▲	△
CODE WORD			●	○	▲	▲	△
SYSTEM MANAGEMENT & CONTROL							
JOURNALING/LOGGING	●		●	○	▲	▲	△
MESSAGE RECOVERY RETRIEVAL	●		●	○	▲	▲	△
SERVICE MESSAGE GENERATION	●		●		▲	▲	
FLOW CONTROL		●		○	▲	▲	△
STATISTICS GENERATION	●	●	●	○	▲	▲	△
BILLING		●			▲	▲	
STATUS MONITORING	●	●	●	○	▲	▲	△
MESSAGE TRACE	●	●	●		▲	▲	
USER INTERFACE							
I/O MEDIA/SYSTEM CONVERSIONS				○			△
FORMAT & CODE				○			△
SIGNAL				○			△
BUFFERING				○			△
MESSAGE HEADER ENTRY				○			△
SEGMENT LEADER ENTRY		●		○	▲	▲	△
EDITING		●			▲	▲	
ECHO		●			▲	▲	
CONNECTION CONTROL		●			▲	▲	
SECURITY							
ENCRYPTION/DECRYPTION	●	●	●	○	▲	▲	△
AUTOMATIC KEY VARIABLE DISTRIBUTION		*				*	
ACCESS CONTROL		*				*	
USER AUTHENTICATION		*				*	
BP/TCC VALIDATION	●	●	●	○	▲	▲	△
SECURITY TRACE AND AUDIT		*				*	
DATA AUTHENTICATION	●	●	●	○	▲	▲	△
TRAFFIC FLOW SECURITY	●	●	●	○	▲	▲	△

● - PRESENTLY PERFORMED BY INDICATED ELEMENTS
○ - PRESENTLY PERFORMED BY SOME TYPES OF THE INDICATED ELEMENT
▲ - ALLOCATED TO INDICATED ELEMENT IN THIS ARCHITECTURE
△ - ALLOCATED TO SOME TYPES OF INDICATED ELEMENTS IN THIS ARCHITECTURE
* - OPTIONAL ALLOCATION TO BE DETERMINED

MID-TERM FUNCTIONAL ALLOCATION

FIGURE 16

with other I-S/A AMPEs will allow the transfer of information concerning the origin of the message and processing required.

(b) AUTODIN II Subscribers. These Subscribers will be in AUTODIN I or AUTODIN II format. The AUTODIN I format messages will be transferred to the store-and-forward portion of the I-S/A AMPE and processed as described above. For AUTODIN II format transactions, the I-S/A AMPE will perform PSN TAC equivalent functions, segment the data and forward it to the PSN. The PSN will accept traffic one segment or character at a time from the subscriber, make prescribed control, security and community of interest checks, format the segment into a packet for network transmission and send each packet separately into the network on the appropriate trunk.

(2) Security. The security subsystem for the Alternative 1 mid-term architecture should provide the capability to support both end-to-end encrypted (E^3) users and link encrypted users. It is expected that this mix of E^3 and non-E^3 users will persist throughout the mid-term and well into the far-term.

(a) The non-E^3 users will be provided security service through the use of conventional link encryption techniques such as those employed in AUTODIN I and AUTODIN II. Non-E^3 users will be supported by a variety of link encryption devices. Non-E^3 users will be afforded end-to-end security in the mid-term IAS through a combination of link encryption and security kernels used in the IAS network elements. These users will also be provided with traffic flow security protection through the inherent features of the link key generators employed for encryption/decryption. This class of user, however, will not be provided with automatic access control, user authentication, or on-line key distribution.

(b) The E^3 users will be provided service through the application of BLACKER hardware and supporting security software integrated in the various system elements of the IAS. The allocation of BLACKER components to the IAS elements is discussed in Appendix 4. E^3 subscribers should be capable of accessing network services (e.g., message processing, mailbox, teleconferencing), as well as other E^3 subscribers. Furthermore, E^3 subscribers and non-E^3 subscribers should be able to access each other.

(3) System Control. The Alternative I mid-term architecture will make use of available and planned DCS

system control capabilities and resources. This architecture does not require changes to the system control functions of the AUTODIN II PSNs and Network Control Center (NCC). Introduction of the I-S/A AMPE and CSF will allow monitoring, control, reporting and restoral functions to be performed at various levels in the network and thus improvements should be realized in efficiency and reaction time.

As major message processing elements the I-S/A AMPE and CSF must perform most of the system control functions performed by the ASC and some of those performed by the PSN. The Automated Technical Control (ATEC) improvement will be completed prior to implementation of these elements, and they should have the ATEC Station level capabilities. Table 6 lists the major system control functions required in the I-S/A AMPE and CSF.

Since the I-S/A AMPE will terminate the majority of narrative/record subscribers in the system it will be necessary for them to collect and report subscriber traffic statistics for billing purposes. They will also record the status information and statistics necessary to support system engineering and traffic management.

2. Alternative II.

a. General. This alternative represents a distributed architecture in which user and network services are provided from a common access area element. This results in a flexible structure in the access area with services accessed both directly and via the backbone network. In addition, this architecture provides the maximum degree of commonality among network elements.

b. Elements. The major elements of Alternative II are the PSN, I-S/A AMPE(E), I-S/A AMPE and subscriber terminals. This alternative does not include a CSF.

(1) The PSN, I-S/A AMPE and subscriber terminals used in Alternative II are the same elements as those discussed in Alternative I and will not be repeated.

(2) Inter-Service/Agency AMPE Enhanced (I-S/A AMPE (E) Phase II). The I-S/A AMPE(E) will fulfill the two distinct roles. It will function as a normal I-S/A AMPE for its locally connected subscribers. In this role it will provide local terminal support and message processing functions and act as the network front end. Secondly, the I-S/A AMPE(E) will serve as a network service element. In this role the I-S/A AMPE(E) will provide network services to both locally

TABLE 6

CSF AND I-S/A AMPE SYSTEM CONTROL FUNCTIONS

Network Control Functions

- * . Patch and Test Facility
- * . Intersystem Interface
- . Internal Control
  - - Restart/recovery
  - - Program/table reload
  - - Diagnostics
  - - Hardware/software monitoring
- . Statistics Generation (Circuit Outage, Circuit Performance, etc.)
- . Circuit Restoral/Reconfiguration

Traffic Control Functions

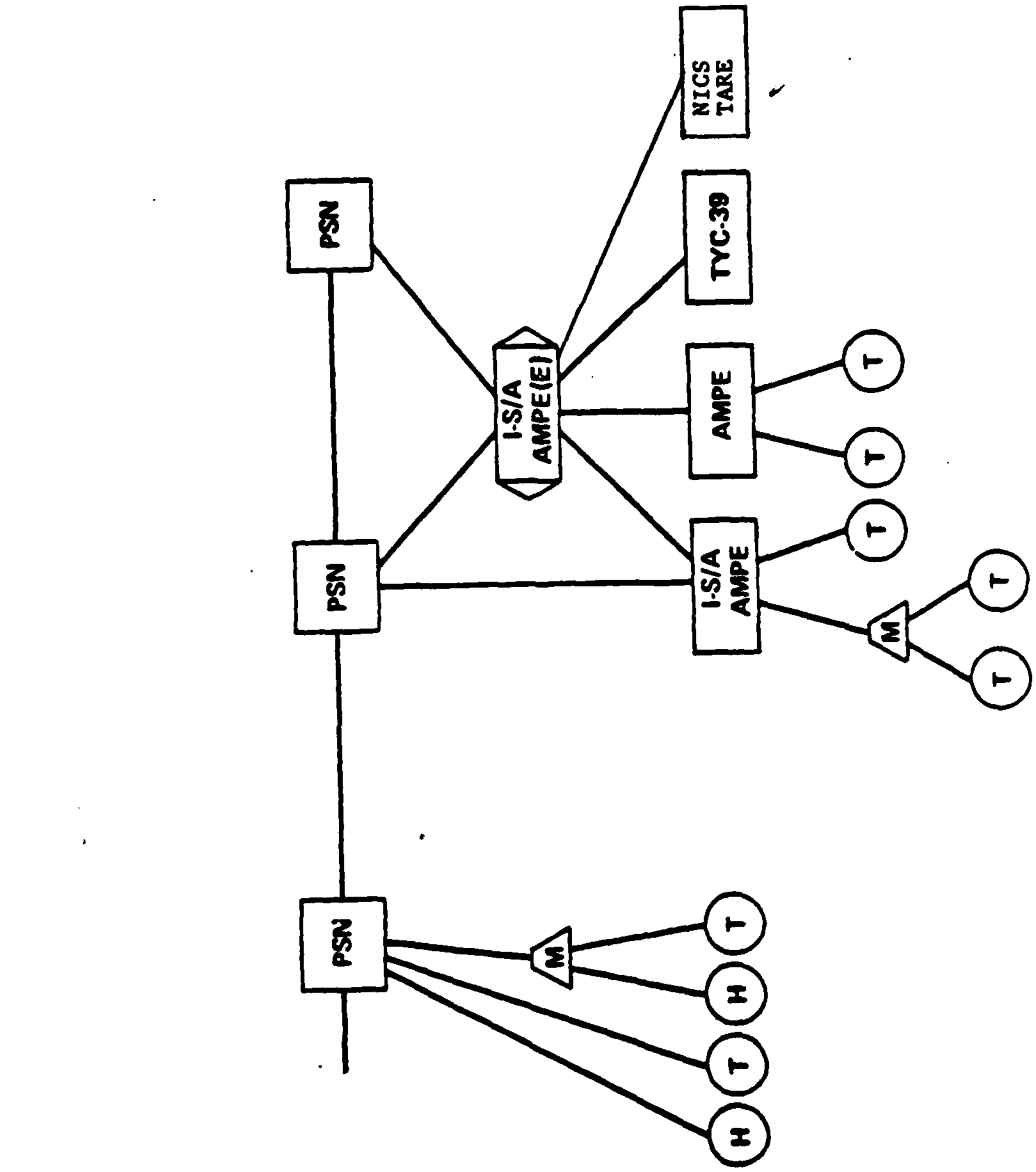
- . Message Routing
- * . Message Distribution
- . Traffic Flow Control
- . Traffic Accountability and Integrity
- . Status Monitoring/Performance Assessment (Traffic conditions, backlogs, resource utilization)

* NOTE: I-S/A AMPE Functions only

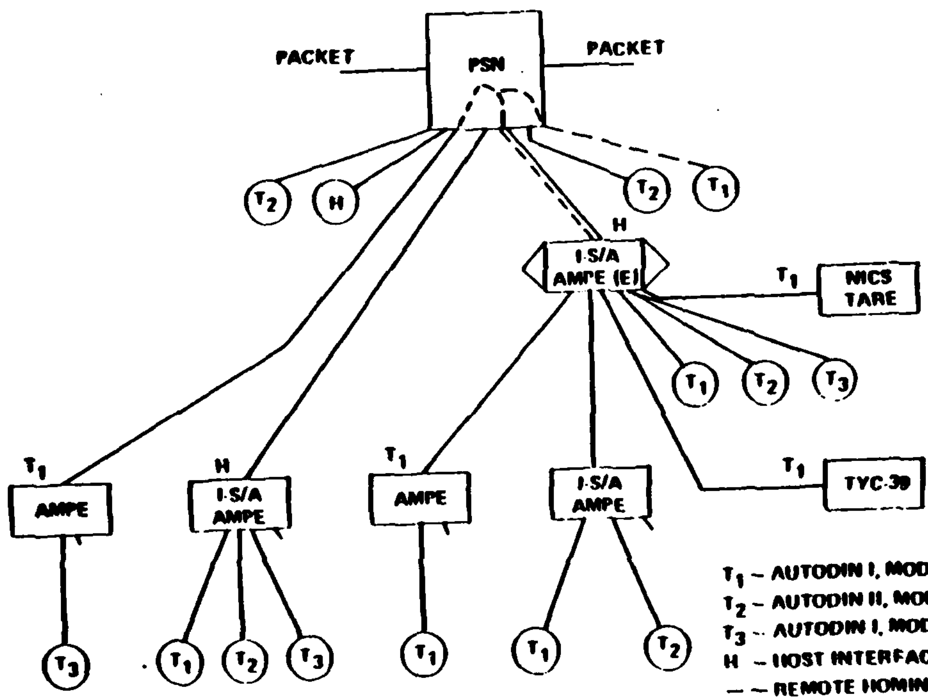
connected and remote access subscribers throughout the network. As a network service element, the I-S/A AMPE(E) will support/augment the capability of the lower level I-S/A AMPE and terminal elements by performing message/ data processing services that require processing and/or data storage capacity beyond that available in the lower level elements. Typical services in this category include: code/ format conversion; message exchange with systems outside the IAS; file storage, update, and retrieval; and telecommunications conference control and record keeping. Shared network use of these I-S/A AMPE(E) capabilities will significantly reduce the processing and storage requirement of the local I-S/A AMPE and terminal equipments. This in turn should significantly reduce the total network acquisition and operating cost to provide a given level of network service. The I-S/A AMPE(E) will be developed under the same program as the I-S/A AMPE and will share its basic software modules with the I-S/A AMPE. The block diagram contained in Alternative I (Figure 10) therefore, is also applicable to the I-S/A AMPE(E). The I-S/A AMPE(E) will include additional software modules, additional hardware processing and storage capacity, and additional communications interface hardware/ software than the basic I-S/A AMPE. As indicated previously the I-S/A AMPE(E) installations will in many cases be accomplished by retrofit/upgrade of previously installed I-S/A AMPEs.

c. Configuration/Connectivity. The basic configuration of network elements is illustrated in Figure 17. Figure 18 illustrates all single connections (both preferred and alternative) between elements. As indicated in this diagram, AUTODIN I type subscribers (including AMPEs) connected to PSNs will enter messages in AUTODIN I formats via the PSN TAC and all of their traffic will be automatically routed (cut-through) to a designated I-S/A AMPE(E) for processing. Since the PSNs do not process AUTODIN I precedence and security format elements, all cut-through traffic will be handled at the highest level precedence and security. For this reason, direct connection of AUTODIN I type subscribers to I-S/A AMPEs or I-S/A AMPE(E)s is preferred to PSN connection.

(1) Terminals may be dual homed to any combination of the applicable nodal element types, i.e., PSN, I-S/A AMPEs, or I-S/A AMPE(E)s may be connected to PSN or I-S/A AMPE(E)s and can be dual homed to one or both of those elements types. Since some I-S/A AMPE traffic will require routing to an I-S/A AMPE(E) for service and some will be routed directly through the PSN network, the preferred connectivity for an I-S/A AMPE will be dual connection to both a PSN and an I-S/A AMPE(E). Depending on the specific



ALTERNATIVE II CONFIGURATION
FIGURE 17



T_1 – AUTODIN I, MODE I
T_2 – AUTODIN II, MODE I, IB, IIA, VI
T_3 – AUTODIN I, MODE II, V OR USER UNIQUE*
H – HOST INTERFACE MODE VI, BSL
– – REMOTE HOMING VIA "CUT THROUGH"

* NOT ALL MODES AT ALL NODES

ALTERNATIVE II CONNECTIVITY
FIGURE 18

communities of interest served by an I-S/A AMPE and the proportions of traffic types, it will be possible to connect an I-S/A AMPE to either one of those element types. I-S/A AMPEs will not normally be directly interconnected, but for contingencies may connect using Mode I or VI protocols.

(2) I-S/A AMPE(E)s will access the network directly via a PSN. They will normally be dual homed to PSNs for survivability.

(3) Tactical and NATO system interfaces in AUTODIN I subscriber modes will have the same connection options as AUTODIN I terminals, and for the same reasons, connection of AN/TYC-39 and NICS TARE relays to an I-S/A AMPE or I-S/A AMPE(E) is preferred.

(4) The interconnectivity of all network elements is summarized in Figure 19. The connectivity options offered by the architecture allow flexibility for overseas deployment. In general, the backbone IAS network will be extended by locating PSNs overseas. Alternatives for overseas implementation are discussed in Section IV.

d. Protocols. Alternative II link level and network level protocols are the same as for the corresponding elements in Alternative I. Since the I-S/A AMPE(E) is a modular enhancement of the I-S/A AMPE, the protocol examples provided in Alternative I Figures 13, 14, and 15 apply. Figure 13 summarizes the link protocols. Figure 14 illustrates the primary layers of protocols required for transactions between an I-S/A AMPE(E) connected AUTODIN II terminal and an AUTODIN II connected host computer. Figure 15 shows the network protocols for an AUTODIN I transaction between I-S/A AMPE(E) connected subscribers.

e. Functional Allocation. The availability of services for the various types of subscribers is about the same in Alternative II as in Alternative I. The only exception is that the functions are allocated to the I-S/A AMPE(E) instead of the CSF (see Figure 16).

f. Operational characteristics. Traffic in this architecture alternative will flow from source to destination through one or more intermediate nodes. Narrative record traffic will generally flow through an intermediate I-S/A AMPE(E) and will, therefore, receive necessary terminal support and network service processing enroute. All network subscribers will access network

FROM \ TO	PSN	I-S/A AMPE(E)	I-S/A AMPE	AMPE	HOST	TERMINAL
PSN	BACKBONE NETWORK	CONNECTED TO MULTIPLE I-S/A AMPE(E)	CONNECTED TO MULTIPLE I-S/A AMPEs	*†CONNECTED TO MULTIPLE AMPEs	CONNECTED TO MULTIPLE HOSTS	CONNECTED TO MULTIPLE TERMINALS
I-S/A AMPE(E)	DUAL CONNECTED	*	CONNECTED TO MULTIPLE I-S/A AMPEs	CONNECTED TO MULTIPLE AMPEs	*	CONNECTED TO MULTIPLE TERMINALS
I-S/A AMPE	SINGLE OR DUAL	SINGLE OR DUAL	*	CONNECTED TO MULTIPLE AMPEs	*	CONNECTED TO MULTIPLE TERMINALS
AMPE	†*NORMALLY SINGLE, OPTIONALLY DUAL	NORMALLY SINGLE, OPTIONALLY DUAL	NORMALLY SINGLE, OPTIONALLY DUAL	NA	NA	CONNECTED TO MULTIPLE TERMINALS
HOST	SINGLE OR DUAL	*	*	NA	NA	CONNECTED TO MULTIPLE ADP STATIONS
TERMINAL	NORMALLY SINGLE, OPTIONALLY DUAL	NORMALLY SINGLE, OPTIONALLY DUAL	NORMALLY SINGLE, OPTIONALLY DUAL	NORMALLY SINGLE, OPTIONALLY DUAL	NORMALLY SINGLE, OPTIONALLY DUAL	NA

* THESE CONNECTIONS WILL BE CONSIDERED ON A CASE-BY-CASE BASIS.
† CONNECTED FOR TERMINATION ONLY. SERVICES ARE PROVIDED BY OTHER ELEMENTS.
NA NOT APPLICABLE.

MID-TERM CONNECTIVITY MATRIX
FIGURE 19

services from the nearest available I-S/A AMPE(E). The Alternative II approaches to traffic flow, Security and System Control are addressed in the succeeding sub-paragraphs.

(1) Traffic Flow:

(a) AUTODIN I connected subscribers to an I-S/A AMPE(E). Traffic submitted to the I-S/A AMPE(E) from AUTODIN I subscribers will be addressed with Plain Language Addresses (PLAs) or Routing Indicators (RIs) and may be forwarded in any one of the AUTODIN formats (JANAP 128, ACP-126-127, DOI-103, DD173. This traffic will be automatically transferred to the store-and-forward message processing portion of the I-S/A AMPE(E) where AMPE and AUTODIN I type functions are performed (see Figure 10). Local distribution to directly connected subscribers (including allied/tactical) will be made directly from the I-S/A AMPE(E) as required. The I-S/A AMPE(E) will segment and forward the messages, through the PSN network, to the destination I-S/A AMPE(E), I-S/A AMPE or PSN - connected subscriber. As part of the Virtual Message Protocol, the originating I-S/A AMPE(E) will provide information to the destination I-S/A AMPE or I-S/A AMPE(E) concerning the origination code and format to allow necessary conversions to be made for the destination subscriber. PSN -connected subscribers that are transferred to the originating I-S/A AMPE(E) will be treated as local subscribers by that I-S/A AMPE(E). Transmission logs, histories and retrieval storage will be maintained at the basic or enhanced I-S/A AMPE unless the originating subscriber is designated/ authorized for limited privacy service in which case no permanent storage of the message is maintained.

(b) AUTODIN II connected subscribers to an I-S/A AMPE(E). These subscribers may enter traffic in any one of the AUTODIN I formats or in AUTODIN II formats. The traffic entered in AUTODIN I format will be addressed using PLA or RI. It will be forwarded to the store-and-forward portions of the I-S/A AMPE(E) and handled as described above. Traffic entered in AUTODIN II format will provide segment leader information with each transaction and the text will be free format, i.e., the message format may be one of the AUTODIN I formats or other user-to-user format. For host computer transaction transfers requiring no additional processing, the I-S/A AMPE(E) segments the traffic and forwards it to a PSN for routing. No local routing is done for this type of traffic by the I-S/A AMPE(E). The I-S/A AMPE will recognize, via segment leader designators, transactions that require services provided only by an I-S/A AMPE(E), such as mailbox or teleconferencing, and will

AD-A103 889 DEFENSE COMMUNICATIONS AGENCY ARLINGTON VA F/G 17/2
INTEGRATED AUTODIN SYSTEM ARCHITECTURE REPORT. PART 2.(U)
MAR 79

UNCLASSIFIED NL

END
DATE
FILMED
0 81
DTIC

forward the transaction to an I-S/A AMPE(E) by inserting a segment leader with the I-S/A AMPE(E) address. Otherwise, segments will be relayed through the I-S/A AMPE containing only the destination address.

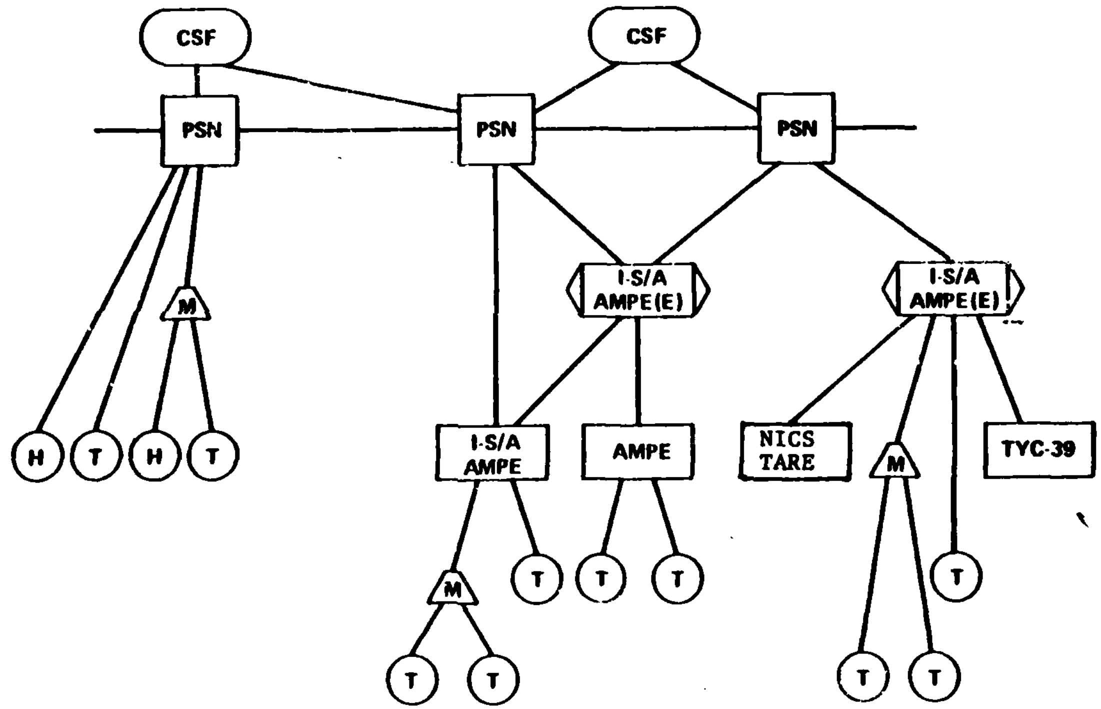
(c) AUTODIN I Connected Subscribers to a PSN. AUTODIN I subscribers connected to PSNs will be automatically transferred to a designated I-S/A AMPE(E). All traffic generated by these subscribers will be automatically routed to the I-S/A AMPE(E) which will process the traffic as if it came from a local AUTODIN I subscriber. Traffic generated by AUTODIN II subscribers connected to PSNs must be in AUTODIN II format with segment leader information provided. Transactions which require I-S/A AMPE(E) services will be addressed to an I-S/A AMPE(E) since the PSNs will not recognize the need for such services.

(2) Security. Security for non-E^3 users is provided in this alternative and is similar to that of Alternative I. Also, security for E^3 users is provided in the same manner as in Architecture I except that the BLACKER elements may be located at different places in the network. Trade-offs for location of these elements are discussed in Appendix 4.

(3) System Control. System control considerations for Architecture II differ from those of Architecture I because of the existence of I-S/A AMPE(E)s and the absence of CSFs. Since the I-S/A AMPE(E) services narrative/record subscribers, it will be required to perform all the system control functions of the CSF of Alternative I. The same functions apply to the I-S/A AMPE in Architectures I and II. Table 6 lists the major system control functions required in the I-S/A AMPE and the CSF; those CSF functions apply under this alternative to the I-S/A AMPE(E). Although the functions listed apply to both the CSF and I-S/A AMPE(E) elements, the scope of the functions will be different. For example, the I-S/A AMPE(E) will collect reports from a number of I-S/A AMPEs and generate a consolidated report to the NCC or other DCS control centers.

3. Alternative III.

a. General. This alternative represents a hybrid architecture between the centralized structure of Alternative I and the distributed structure of Alternative II. In this architecture, some services are provided by a centralized backbone service element and some services are provided by a distributed access area element. Figure 20 shows the



ALTERNATIVE III CONFIGURATION
FIGURE 20

major elements of Architecture III and their interconnections.

b. Elements. The major elements which comprise Architecture III are the PSN, I-S/A AMPE, I-S/A AMPE(E), CSF and subscriber terminals. The PSN, I-S/A AMPE, and subscriber terminals are the same elements described for Architecture I and II. The I-S/A AMPE(E) is the same as described for Architecture II except that it does not provide the new IAS network services. As in Architecture II, the I-S/A AMPE(E) performs the AMPE functions and ASC terminal support and network functions, and is a modular enhancement to the I-S/A AMPE. A Central Service Facility (CSF) is provided in Architecture III to perform the new functions identified for the mid-term and is also the primary expansion element to assume new functions as new requirements are identified. The CSF connects to one or more PSNs as a host computer. Although it provides user service via network access, it does not terminate subscribers.

c. Configuration/Connectivity. Connectivity options for all common elements are the same for Architecture III and Architecture I. The CSF connects only to PSNs and uses an AUTODIN II, Mode VI, Binary Segment Leader host interface. Gateways to external packet networks would be implemented in the CSF. New narrative/record interfaces to existing tactical elements such as the TYC-39 can be implemented in the I-S/A AMPE or I-S/A AMPE(E).

d. Protocols. As for Architecture II, Architecture III requires no new protocols to be implemented in existing elements. Link level and network level protocols are the same as for the corresponding elements of Architecture II. The CSF will communicate through the PSN network with other host computers, I-S/A AMPEs, I-S/A AMPE(E)s and terminals as a host computer and will therefore implement SIP, TCP and THP protocols.

e. Functional Allocations. The availability of services to the various types of subscribers is the same in Architecture III as in Architecture II except that some of the services are obtained from the CSF instead of the I-S/A AMPE(E). (See Figure 16).

f. Operational Characteristics. The differences in operational characteristics of Architecture III and Architecture II are described in the following sub-paragraphs in terms of traffic flow, security, and system control.

(1) Traffic Flow. One major difference in the traffic flow of Architectures II and III is the splitting of services between the CSF and the I-S/A AMPE(E) in Architecture III.

(2) Security. Security for non-E^3 users is provided in Architecture III as it is in Architecture II. Security for E^3 users is provided in the same manner as Architecture II except that the BLACKER elements may be located at different places in the network.

(3) System Control. System control considerations are essentially the same for Architecture III as for Architecture II except that an additional requirement will exist for control of the CSFs and performance of system control functions by the CSFs.

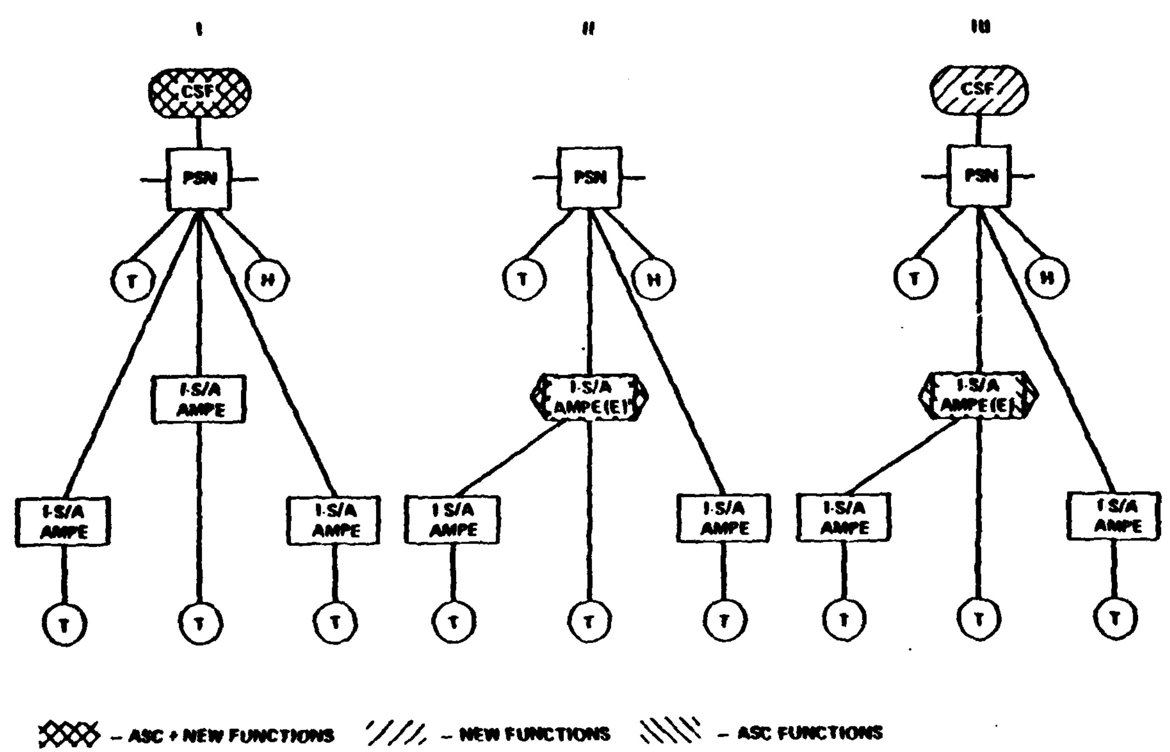
4. Summary. The basic configuration, nodal element types, and functional allocation for the three alternative architectures are summarized in Figure 21. This figure presents a simplified representation of each architecture. As discussed earlier in this section, these three alternatives represent the three major classes of architectures (centralized, distributed and hybrid) applicable to the IAS mid-term. Each of these architectures provides the required mid-term IAS services and functions and is consistent with the contraints and anticipated operating environment of the mid-term. In addition, each of these alternative architectures represents an evolutionary departure from the near-term IAS architecture described in Section II.

D. Evaluation of Alternatives.

1. General. To determine the preferred IAS mid-term architecture, the three alternative architectures described above were evaluated with respect to both technical and cost factors. This evaluation was based on a series of quantitative and qualitative technical analyses performed in support of the IAS architecture definition. In order to provide a high degree of confidence in the final results of the evaluation, the general approach to alternative evaluation was based on the following guidelines:

- Evaluation on the basis of comparative/relative performance vice absolute performance estimates

- Application of quantitative analytic techniques wherever possible and appropriate



IAS ALTERNATIVE ARCHITECTURES
FIGURE 21

- Consideration of all relevant factors in subjective/qualitative analyses
- Careful documentation of factors considered and basis for subjective decision
- Thorough review of analysis methods and results
- Final evaluation based on preference/rank order vice measure of effectiveness

The eventual performance of any system is difficult to measure at such an early stage of architectural definition; detailed system performance requirements based on future user applications/needs cannot be specified until later in the system definition/design cycle; and each alternative archtecture is capable of meeting the anticipated future performance requirements through design tradeoffs within the state-of-the-art; therefore, the differences between alternative architectures were, in many cases, measured in terms of the difficulty or complexity of meeting performance objectives in given areas based on inherent architecture characteristics. Examples of such characteristics are: (1) the number of nodal and transmission delays that must be encountered from user to user/service element; (2) the number of different nodal elements contained in the network and the degree of commonality among elements; (3) the number of operations required to complete a message transfer including intermediate processing; and (4) the number of elements available/required for user connection/service access. In order to facilitate evaluation of the alternative architectures, the results of these studies are summarized in the following paragraphs.

2. Evaluation Criteria and Comparison. Five major evaluation criteria are operational effectiveness, flexibility, survivability/availability/supportability, transition and cost. Within each criterion, from two to six sub-criteria were considered. Within each sub-criterion, one to sixteen factors and sub-factors were evaluated. On the basis of the technical analyses performed as part of the evaluation process, the relative advantages and disadvantages of each alternative were identified. The following sub-paragraphs define each major criterion and present the results of the evaluation process.

a. Operational Effectiveness.

(1) Definition. This criterion addresses the relative efficiency and effectiveness of an architecture for providing the required functional capability. The sub-criteria

used in this category were speed of service, user interfaces, transmission overhead, system motivated functions, security and adaptability to overseas. Lower level factors and sub-factors used in the sub-criteria were: speed of service by traffic type (e.g., interactive, query/response, key distribution, mailbox); interface complexity for access to and interaction with network services; transmission overhead by network function (e.g., addressing, normal routing, CARP routing, flow control, error control, system control); complexity of system motivated functions (e.g., system control, accountability); ability to meet security objectives (e.g., end-to-end encryption, minimum number of "RED" elements required, future security growth capability); ability to support mobile terminals, ability to use mobile/transportable elements based on element size and potential user impact; risk of overseas deployment associated with PSN, CSF, I-S/A AMPE(E); size of CONUS/ overseas trunks; and survivability.

(2) Technical Factors Comparison. Alternative I with its CSF and direct connection of subscribers and I-S/A AMPEs to PSNs was determined to provide the best potential for performance in this evaluation category. Due to its less complex structure and direct user access, Alternative I could potentially provide a slight advantage over the other two alternatives in the areas of service delivery time and application to overseas operating environments. However, each of the alternative architectures is capable of meeting the functional performance requirements and the anticipated technical performance requirements of the mid-term IAS. It should also be recognized that Alternative II and Alternative III provide a high degree of flexibility in the access area through dual connection of the I-S/A AMPE as well as through alternative connections for both narrative/record and computer data subscribers. The system design for the preferred architecture can, therefore, take advantage of these capabilities to provide optimum service access for most users. As a result of system design optimization, the operational effectiveness of the Alternative II architecture will approach the optimum available performance.

b. Flexibility.

(1) Definition: This criterion measures the ability of an architecture to accommodate change. Two sub-criteria were defined in this category--adaptability and expandability. Adaptability refers to the ability of an architecture to accommodate changes in the demand or utilization of its planned capabilities. Expandability measures the ability of the architecture to accommodate additional requirements. Adaptability factors include the impact of changes in: traffic types (bulk versus narrative/record,

secure versus non-secure), external interfaces, network services, subscriber/ traffic distribution (PSN versus I-S/A AMPE connected, geographic distribution, local versus remote, ratio of AUTODIN I/AUTODIN II subscribers). Expandability factors include the potential impact of additional subscribers (number, types), protocols (user/user, user/service, link), services, control functions, traffic, and external interfaces.

(2) Technical Factors Comparison. Alternative I is potentially less sensitive to changes in the day-to-day network operation within the original system design limits due to its relatively flat structure (no access area hierarchy) and its potential for load sharing of processing within a single service element (i.e., the CSF). However, Alternatives II and III were found to be significantly more flexible and less sensitive to major changes in requirements and future growth because of the greater number of connection/configuration options available within these architectures. In addition, it should be noted that the implementation of the new IAS network elements can potentially have as much impact on system flexibility as the architecture selected. For example, it is anticipated that the I-S/A AMPE and the I-S/A AMPE(E) will be implemented based on a multiprocessor architecture. This will permit the high degree of expandability required to permit graceful evolution of the I-S/A AMPE throughout the mid-term and protect against saturation of the I-S/A AMPE processing capability.

c. Survivability/Availability/Maintainability.

(1) Definition. This criterion considers the inherent ability of an architecture to provide the required service in both normal and hostile operating environments. The subcriteria defined in this category include: the effect of nodal/link failures on system operation, the ability of the architecture to protect against nodal/link failures, the ability of the architecture to recover from failures and the maintainability of the architecture. Lower level factors considered within this criterion include the potential loss of service and access, the complexity of CARP (source/network), dual homing flexibility, ability to support redundant nodes, number of elements requiring support and degree of commonality among elements.

(2) Technical Factors Comparison. Alternative II offers a high degree of hardware/software commonality and therefore minimizes the availability/maintainability requirements of the network. In addition, Alternative II offers improved survivability through dual connection of the I-S/A AMPEs and increased independence of the I-S/A AMPEs for message transfer operations.

d. Transition.

(1) Definition. This criterion considers the ability of an architecture to evolve from the near-term to and beyond the specific mid-term architecture. Sub-criteria identified within this area were technical risk, user impact, ease of implementation, and potential for continued evolution. Lower level factors include hardware and software development risks, continuity/disruption of service, availability of requred elements, extent of modifications required to existing elements, consistency with far-term architectural objectives (e.g., satellite broadcast backbone, integrated voice and data).

(2) Technical Factors Comparison. Alternative II represents the best architectural basis for transition from the near-term to the mid-term IAS network. In addition, Architecture II offers the best architecture for continued evolution through the far-term toward the DCS objectives of both satellite broadcast backbone utilization and integration of voice and data networks. In general, Alternative II represents the least risk and difficulty for transition because only a single network service element must be implemented (i.e., I-S/A AMPE(E)). In addition, development/implementation risk is further reduced because the I-S/A AMPE(E) is derived from the currently planned I-S/A AMPE program. It should be noted that the risk assessment performed as part of the evaluation was based upon the overall IAS implementation strategy and technology trends defined in the IASA Report (Part 1) (i.e., common family of hardware/transportable software, multi-processor nodal architecture).

e. Costs.

(1) Definition. This criterion measures the potential of each architecture for reducing the cost of ownership and operation of the mid-term IAS. Major cost elements considered as sub-criteria within this category are transmission costs, nodal element acquisition costs, and operation and maintenance cost. Lower level cost factors include initial and recurring costs associated with backbone trunks and access area communications facilities, hardware and software investment costs, and personnel support and training costs.

(2) Cost Factors Comparison. As part of the alternative evaluation process, a comparative cost analysis was performed and is provided in Appendix 3. This analysis identified all major cost components of the mid-term IAS and evaluated those factors which were found to be dependent

upon network architecture. The results of the analysis indicated that when each of the alternative factors were compared no overriding preference for a preferred architecture was apparent. However, the relative weight of each cost factor should be considered when viewing even a relative low percentage of differences (e.g., operation and maintenance costs point to Alternative II with approximately 3% savings over the other alternatives), which is used as a consideration in selecting the preferred architecture.

f. Summary. Based upon the results of the evaluation process the preferred architecture for the mid-term IAS will be based upon Alternative II. This alternative was determined to be preferred to each of the other alternatives in three of the five major evaluation criteria. In addition, Alternative II was evaluated to be preferred in the two technical criteria which are considered the most important for the mid-term IAS--transition and survivability/availability/supportability. A principal characteristic of this architecture which led to its selection is the consolidation/integration of network and user motivated functions into a single service element based upon the currently planned Inter-Service/Agency AMPE Program. This consolidation/integration provides significant potential benefits in both cost and performance and contributes materially to the ease of transition from near-term to the mid-term network architecture.

3. Comparison of Preferred Alternative with the Baseline Projected to 1988.

a. Definition. In order to gain insight into the potential advantage of implementing the preferred, Alternative II, mid-term IAS architecture, a comparison is made of the preferred architecture with the 1983 baseline architecture projected to a probable 1988 configuration. The baseline architecture used in this analysis would incorporate only those changes and upgrades required to maintain current system capabilities. Based on current DoD policy, the 1983 baseline architecture includes provision for replacement of existing AMPEs with the I-S/A AMPE. However, because these new AMPE systems would not have the additional capability of the I-S/A AMPE(E) used in the preferred architecture, it is unrealistic to assume that consolidation could be achieved in the projected 1983 baseline architecture. Therefore, the number of AMPEs projected for the 1988 configuration was derived from current and planned AMPE requirements (see Appendix 2). In addition, technical factors of the projected 1988 architecture are presented in Appendix 3.

b. Technical Factors Comparison. This analysis includes an evaluation of nodal element acquisition costs and personnel requirements for the preferred architecture and the 1983 baseline projected to 1988.

(1) Nodal Element Acquisition. This cost comparison indicated that a total estimated acquisition cost of the preferred architecture is approximately (DELETED) greater than the projected baseline. (See Table 20, Appendix 3).

(2) Personnel requirements. The manning estimates for proposed new IAS elements were obtained using the available ASC and AMPE information as a baseline. As previously stated, the cost comparison data between alternatives was not a deciding factor for selection of a preferred alternative. However, the comparison of operation and maintenance personnel costs for the preferred architecture versus the baseline projected to 1988 indicates a potential savings of about 2000 personnel which equates to $39 million per year. (See Table 7, page 95). The magnitude of the potential savings indicated by this analysis demonstrate an opportunity for a reduction of total AUTODIN operation and maintenance costs through the implementation of the preferred mid-term architecture.

E. Summary. The preferred architecture for the mid-term Integrated AUTODIN System (IAS) is based on the selection of Alternative II, which represents a distributed architecture where services are provided from a common access area element. This architecture meets all anticipated mid-term IAS operational requirements and provides a substantial improvement over the near-term. The preferred architecture provides significant advantages over the baseline (1983) projected to 1988 in terms of transition capabilities (both for the mid-term and beyond), survivability/availability and costs.

1. Elements. The preferred mid-term IAS architecture will use a combination of existing and newly developed network elements. The major elements of the architecture and their application/role in the architecture are:

a. Packet Switch Node (PSN). The AUTODIN II PSN should not require any modifications.

b. Inter-Service/Agency AMPE (I-S/A AMPE). The I-S/A AMPE is used in the preferred architecture as both a local message processing service element an a communication network front-end.

c. Inter-Service/Agency AMPE Enhanced (I-S/A AMPE(E)). In the preferred architecture, the I-S/A AMPE(E) will fill two distinct roles. First, it will function as a normal I-S/A AMPE for its locally connected subscribers. In this role it will provide local terminal support and message processing functions and act as the network front-end. Secondly, the I-S/A AMPE(E) will serve as a network service element and it will provide the basis for network expansion through upgrade of installed I-S/A AMPEs to enhanced I-S/A AMPE(E) configurations. Based on a modular, transportable software development approach, it is anticipated that any I-S/A AMPEs can be converted to enhanced status after installation. The I-S/A AMPE family of equipments is, therefore the key to both implementation and continued evolution/growth of the IAS network.

d. Subscriber Terminals. The mid-term IAS will have to support all existing types of AUTODIN I and planned AUTODIN II terminals. It is also expected that terminals with additional capabilities will be introduced in the mid-term as part of the common family of AUTODIN terminals. Although increased capability in some terminals will not relieve the network of supporting the remainder of less capable terminals, it can reduce the processing load on the network and reduce the dependence of the terminals on other network elements.

2. Benefits. The preferred architecture is consistent with the mid-term IAS objective and is capable of providing all of the required services and functions as defined in Section II of this report. In summary, the preferred architecture offers:

a. Significant potential benefits to the entire DoD AUTODIN community.

(1) Reduced Cost of Ownership. The preferred architecture offers significant opportunity for reduction in O&M cost through standardization of Service/Agency message processing and communications hardware, software and operating procedures. Additional savings will result from consolidation of network service elements and local user message processing elements in the access region. Finally, a major cost savings will be possible through personnel reductions as a result of consolidation of AMPE sites into joint Service/Agency multi-user I-S/A AMPE configurations.

(2) Enhanced Survivability. The preferred architecture will provide improved access reliability for

TABLE 7

O&M PERSONNEL COST COMPARISON

1983 BASELINE EXTRAPOLATED TO 1988			PREFERRED MID-TERM ARCHITECTURE (II)		
	TOTAL PERSONNEL	TOTAL COST ($K/YR)		TOTAL PERSONNEL	TOTAL COST ($K/YR)
CONUS:			CONUS:		
8 PSN	504	9,776	8 PSN	504	9,776
4 ASC	388	7,580	8 I-S/A AMPE (E)	680	13,224
103 AMPE	7,725	148,629	50 I-S/A AMPE	3,750	73,200
	+	+	21 AMPE (CURRENT)	+ 1,701	+ 30,303
	8,617	165,985		6,635	126,503
OVERSEAS:			OVERSEAS:		
3 PSN	189	3,666	3 PSN	189	3,666
7 ASC	644	13,265	7 I-S/A AMPE (E)	595	11,571
35 AMPE	+ 2,835	+ 50,505	13 I-S/A AMPE	975	19,032
			10 AMPE (CURRENT)	+ 810	+ 14,430
	3,668	67,436		2,569	48,699
SAVINGS DUE TO COLOCATION OF PSN'S WITH ASC'S (4 IN CONUS, 3 OVERSEAS)	- 140	- 2,786	MANNING REQUIREMENTS FOR 29 AMPES WHICH REVERT TO LOCAL TERMINAL/MESSAGE CENTER STATUS AS A RESULT OF CONSOLIDATION	+ 870	+ 16,559
	12,145	230,635		10,074	191,761
NET SAVINGS ACHIEVED BY PREFERRED ARCHITECTURE				2,071	38,874

NOTES:
1. PERSONNEL LEVELS AND RATES ARE THOSE LISTED IN TABLE 18
2. COST CALCULATIONS ARE BASED ON TYPICAL 1988 NETWORK CONFIGURATIONS.
3. THE PROJECTED BASELINE INCLUDES CURRENT AMPES WHICH WILL BE IN SERVICE THROUGH 1988 AS WELL AS STANDARDIZED AMPES WHICH REPLACE CURRENT AMPES DURING THE MID-TERM.
4. PERSONNEL OVERHEAD COSTS FOR MANAGEMENT, LOGISTICS SUPPORT, TRAINING AND SOFTWARE DEVELOPMENT/MAINTENANCE ARE NOT INCLUDED IN ABOVE FIGURES

users through multiple interconnection of network access nodes (I-S/A AMPE and I-S/A AMPE(E)). In addition, since user access nodes are not dependent on higher level elements for normal message traffic, the loss of a single network element will have little effect on total system operation. In fact, the preferred architecture should provide graceful degradation of service in the face of network node/link losses.

(3) Improved Performance. The preferred architecture will permit the introduction of significant new telecommunication services and features. In addition, the improved access arrangements and distribution of services nodes throughout the access area, will permit improved speed of service and overall increased network responsiveness to user needs. Furthermore, the flexibility inherent in the preferred architecture will allow the mid-term AUTODIN system to accommodate many unique user requirements without penalty to other users.

(4) Evolutionary Transition. The preferred architecture can be implemented in a smooth evolutionary process from the 1983 near-term architecture. In addition, the preferred architecture provides a framework for continued evolutionary development of the IAS through 1988 and beyond.

b. Among the potential benefits of the preferred architecture, the most important may well be its ability to evolve in a smooth and orderly process from the current AUTODIN. In order to demonstrate the feasibility of this transition process, the final Section of this report presents a transition plan for the implementation of the preferred architecture in the mid-term (1984-1988).

SECTION IV

SECTION IV

TRANSITION STRATEGY

A. Purpose. The purpose of this section is to demonstrate the feasibility of achieving the mid-term IAS in an evolutionary manner by defining a transition approach for the mid-term. The near-term IAS serves as a point of departure to the mid-term transition approach by reviewing and updating near-term activities and milestones. A transition strategy is postulated, with alternative approaches where applicable, for evolving from the near-term (1978-1983) to the mid-term (1984-1988). Finally, the sequence of events, milestones, and interdependence of activities for the transition approach are presented.

B. Achieving Evolutionary Transition.

1. General. In accordance with ASD/C^3I direction, the IAS will evolve in a deliberate and continuous fashion from today's communications to the more sophisticated communications of the future. This guidance precludes the possibility of any single "turnkey" type of operation where one system is replaced by another at some pre-established date. Hence, the need for a smooth transition over the next decade becomes paramount to the IAS architectural strategy. Continuity of service and user transparency emerge as important transitional considerations. The incremental addition of new network elements (e.g., PSNs and I-S/A AMPEs) and the concomitant phasing out of obsolete equipment (e.g., ASCs and AMPEs) will characterize the evolution. The transition must be performed within the framework of a circa 1990 IAS, i.e., the employment of equipment, techniques, and philosophies should be consistent with the full range of potential circa 1990 architectures. These considerations and others have been factored into a general approach to achieving evolutionary transition.

In the IASA Report (Part 1), transition strategies were identified for two markedly different, but feasible circa 1990 architectures: one based on terrestrial switching, the other based on broadcast satellite use. It was assumed that the architecture selected for circa 1990 would lie somewhere between these extremes. Since each of the alternatives considered, although differing widely in the backbone architecture, proceeds initially from the present (1979) architecture in the same manner, it was concluded that the chosen architecture would require the same sequence of events in the near-term. Consequently, a single near-term transition approach

was developed. In order to ensure the continued evolution of the IAS beyond the near-term, a transition approach for the mid-term must be defined.

2. Near-Term IAS. The near-term IAS, to be implemented through 1983, is depicted in Figure 22. Subsequent paragraphs describe the network elements, functional allocation, and transitional approach for achieving the near-term IAS.

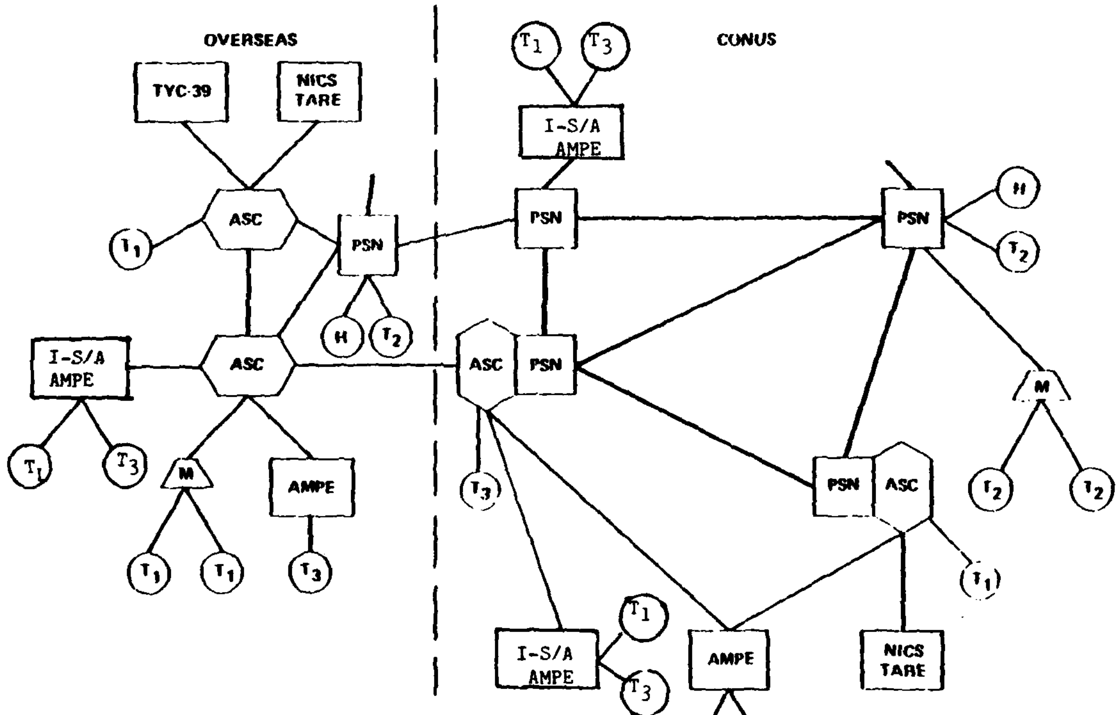
a. Network Elements. In the near-term, the IAS will consist of a set of elements that satisfy validated service requirements with little, if any, technical risk.

(1) AUTODIN Switching Center (ASC). By 1983, eleven to fifteen ASCs should be in operation (six government-owned overseas, one leased in Hawaii, and four to eight leased in CONUS). Overseas ASCs should either be trunked to CONUS ASCs or receive trunking via PSNs. CONUS ASCs should receive their trunking through the PSNs. Functionally, the ASC will be essentially unchanged from what exists today. (See IASA Report (Part 1) for further discussion on factors affecting closures of ASCs.)

(2) Packet Switch Node (PSN). It is expected that eleven PSNs (three overseas and eight in CONUS) should be in place and operational by 1983. The CONUS PSNs may be collocated with the remaining CONUS ASCs and interface via a Mode VI serial communications interface capable of multiple virtual connections. The PSNs will be interconnected by multiple packet trunks operating at speeds from 9.6 to 56 kbps derived from common carrier facilities. In addition to providing packet switching service to AUTODIN II subscribers, the PSN will terminate AUTODIN I, Mode I subscribers e.g., AMPEs. All traffic so received will be transferred to a home ASC for normal AUTODIN I processing.

(3) Automated Message Processing Exchange (AMPE). Service/Agency projections indicate that the number of AMPEs in the near-term IAS should be about 109. AMPE plans are being evaluated on a case-by-case basis. AMPEs will be terminated on either PSNs or ASCs using AUTODIN I, Mode I protocol. For availability and backup purposes, some AMPEs will be dual homed, i.e., connected to either two PSNs, two ASCs, or a PSN and an ASC.

(a) The following AMPE types will operational in the near-term IAS: Army's AMME, Navy's LDMX and



T_1 = AUTODIN I TERMINAL (MODE I)
T_2 = AUTODIN II TERMINAL (MODE I, IB, IIA, VI)
T_3 = AUTODIN I TERMINAL (MODE *II, V, OR USER UNIQUE)
H = AUTODIN II HOST (MODE VI, BSL)
M = MULTIPLEXER

* NOT ALL MODES AVAILABLE AT ALL NODES

1983 BASELINE ARCHITECTURE
FIGURE 22

NAVCOMPARS, Air Force's AFAMPE, NSA's STREAMLINER and DLA's AMPE. All of the AMPEs to varying degrees provide AUTODIN system functions, Telecommunications Center functions, and Customer Assistance functions. Reference is made to the IASA Report (Part 1) for details on these functions.

(b) The functional composition of the AMPEs varies by Service/Agency as each AMPE was designed and developed independently to provide mission-oriented functions and features. Consequently, it is difficult for each AMPE to be used by subscribers outside the intended community of interest. AMPE Functional Comparison studies have addressed this problem and concluded that there is a large amount of functional similarity among the AMME, LDMX, NAVCOMPARS, and AFAMPE systems. As a result, the IASA Report (Part 1) recommended the I-S/A AMPE program replace the current Service/Agency AMPE programs by 1983.

(4) I-S/A AMPE. In the near-term, the I-S/A AMPE program will provide new AMPE systems for Special Intelligence as well as General Service requirements and should be available by 1982. The near-term element of the program is defined as Phase I, by which we will define and develop standard AMPE functions leading to procurement based upon joint functional specifications and release a Request for Proposals during the 1980s, with fielding during fiscal year 1982. Reference is made to Appendix 2 for additional detail on implementation of this Phase I element.

(5) Subscriber Terminals. The near-term will accommodate a wide variety of subscriber terminals, ranging from Model-28 Teletypewriters to sophisticated software programmable devices such as Standard Remote Terminals (SRTs) and ADP hosts. Depending on the service needs of the subscriber, subscriber terminals will be terminated on AMPEs, ASCs, or PSNs. The various termination alternatives available to a subscriber are shown in Table 8. While it would appear that the various programmable devices could be reprogrammed to interface directly with a PSN, each device should be considered on an individual basis to determine the desirability, feasibility and cost-effectiveness of doing so.

b. Transition Strategy. The strategy adopted for transitioning to the near-term IAS is characterized by the sequence of events, target dates, and the interdependencies of events. Table 9 lists the required activities and their associated target dates in chronological order. Figure 23 presents the transition activities as a milestone chart to

TABLE 8

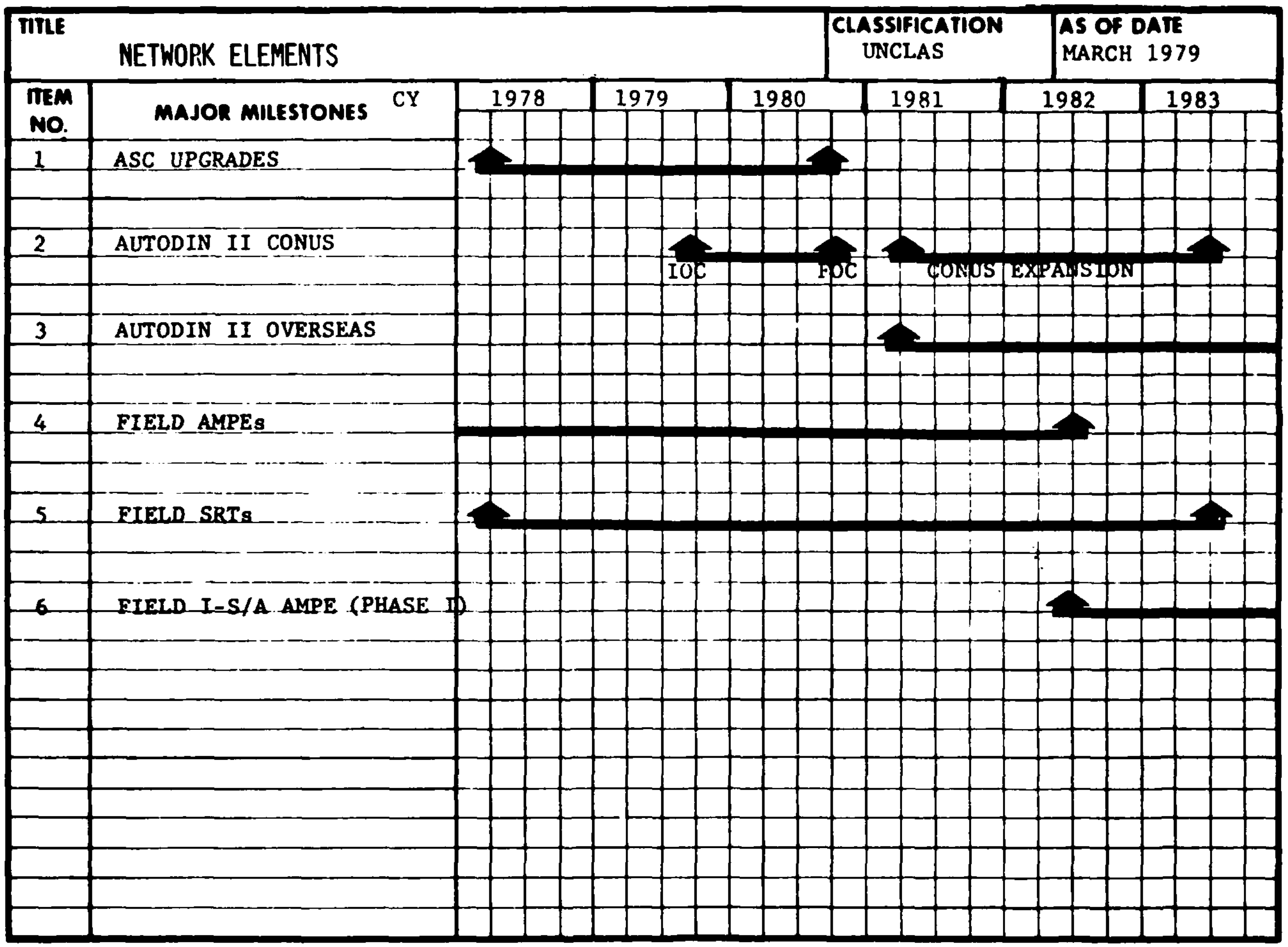
NEAR-TERM IAS TERMINATIONS

		Terminating Device		
	Network Element	AMPE	ASC	PSN
TERMINAL	AMPE	no	yes	yes*
	AUTODIN I Mode I Terminal	yes	yes	yes*
	AUTODIN I MODES II & V Terminal	yes	yes	no
	AUTODIN II Terminal	no	no	yes
	Host (AUTODIN II)	no	no	yes

*Terminated on a PSN but homed to an ASC.

TABLE 9
NEAR-TERM IAS TRANSITION PLAN

Activity	CY Target Date
a. Field AMPEs	In Progress
b. Overseas (O/S) ASC Memory Upgrade	1978
c. CONUS ASC Tape Replacement by Disc	1978
d. Start Fielding SRTs	1978
e. Close One PAC Area ASC (Buckner)	1978
f. Close Second PAC Area ASC (Clark)	1979
g. Select LMD for I-S/A AMPE	1979
h. IOC AUTODIN II Phase I (3 PSNs)	1979
i. O/S ASC Tape, Card Reader and Printer Replacement; Upgrade of Patch and Test Facilities	1980
j. Complete Fielding AUTODIN II Phase I (4 PSNs)	1980
k. Start Phase Out CONUS ASCs; Rehome Affected Subscribers	1981
l. Field Initial O/S AUTODIN II PSNs	1981
m. Start AUTODIN II CONUS Expansion	1981
n. Complete Fielding AMPEs	1982
o. Start Fielding Basic I-S/A AMPE (Phase I)	1982
p. Complete AUTODIN II CONUS Expansion	1983
q. Complete Phase Out (up to Four) CONUS ASCs	1983
r. Near-Term IAS Architecture Achieved	1983



NEAR-TERM IAS MILESTONES

FIGURF 23

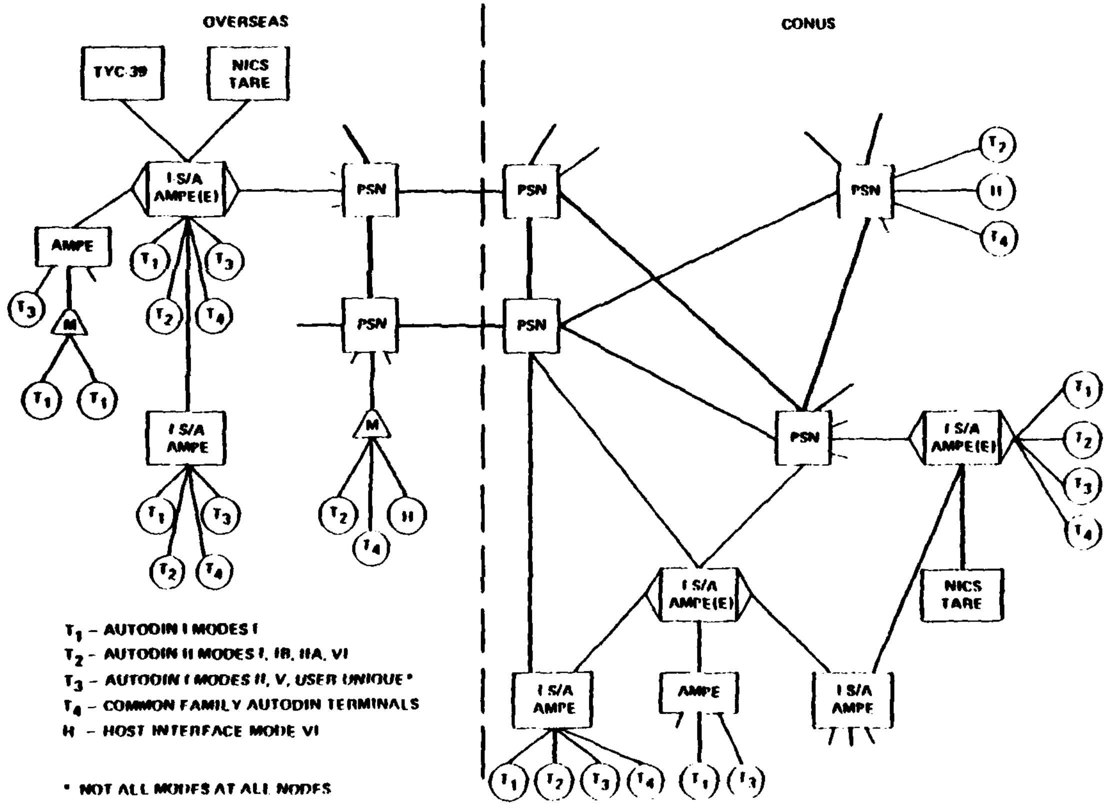
aid in visualizing their interdependencies. The transitional approach is consistent with guidance to achieve the mature circa 1990 IAS in an evolutionary manner for the range of alternative architectures being considered for that time period.

3. Mid-Term IAS. The mid-term (1984-1988) IAS will evolve gracefully from the near-term system and will be consistent with the full complement of potential circa 1990 architectures. Figure 24 depicts the mid-term system as it will appear circa 1988. In contrast with the near-term IAS, which is constrained by the use of existing technology and equipment, the mid-term system begins to exploit the advantages of the state-of-the-art in communications. Accordingly the mid-term transition strategy is driven by the following architectural objectives:

- Replace equipment as it becomes outdated with new or augmented standardized network elements (e.g., replace AMPES with I-S/A AMPEs)
- Preserve continuity of existing network services
- Provide for needed new services
- Develop and field new functional capabilities (e.g., end-to-end encryption with key distribution centers)
- Reduce O&M costs
- Expand AUTODIN II to provide a worldwide data backbone
- Enhance system survivability
- Enhance tactical and allied forces interoperability

With respect to these objectives, there are several transition issues that need resolution. These include:

- User transparency
- Functional allocation/reallocation
  - transfer of functional responsibility (e.g., ASC to I-S/A AMPE(E))
  - field testing of new functional capabilities for user acceptance



MID-TERM IAS ARCHITECTURE
FIGURE 24

- Replacement/integration strategy
  - incremental addition of new network elements
  - cutover strategies
  - phasing out of obsolete or non-cost-effective equipment
  - rehoming affected subscribers
  - impact on remaining network elements
- Overseas implications.

These issues and objectives have been factored into an overall IAS system transition strategy which can in turn be subdivided into more detailed lower level (network element) transition strategies. The intent of the subsequent discussions is to illustrate the overall mid-term transition strategy by identifying transition alternatives at each level.

a. Network Elements. In addition to the near-term network elements, which will exist into and in some instances through the mid-term, a number of new network elements should be implemented in the mid-term.

(1) Inter-Service/Agency AMPE Enhanced (I-S/A AMPE(E)). As stated previously the I-S/A AMPE will be used to satisfy all requirements for new or replacement AMPEs. An enhanced version of this network element, the I-S/A AMPE(E), in addition to providing AMPE functions and services, will assume the functional role of the near-term ASC and will provide network services currently outside the scope of the near-term system.

(2) Central Service Facility (Contingency Option). Although the preferred mid-term IAS architecture does not include this element, the CSF represents a potential system level transition option. This option will be exercised only in the event that new requirements emerge that cannot be accommodated within the I-S/A AMPE(E) program.

(3) Common Family of Terminals (CFT). A new generation of subscriber equipment will be introduced in the mid-term time frame.

(4) Security Components. An end-to-end encryption

(E^3) capability derived from the BLACKER hardware and software developments will be introduced in the mid-term time frame.

b. Transition Strategy. Relative to the mid-term network elements, transition planning focuses on meeting the following specific transition objectives:

- Implementation of the I-S/A AMPE Program
- Expansion of the PSN backbone
- Introduction of the CFT
- Integration of E^3 security into the operational network.

The transition issues relative to each of these objectives are discussed in detail in the remainder of this section.

(1) Implementation of I-S/A AMPE Program.

(a) Development Approach. The I-S/A AMPE program is based on the development of a common standardized set of hardware and software modules. The modular approach of this program coupled with the use of a High Order Language (HOL) for software development should alleviate critical manpower and unique software support requirements that characterized the independent AMPE programs. Accordingly, this approach should result in reduced maintenance costs and greater flexibility in sizing and configuring the access area. Also inherent to this approach is the potential for providing specific functional modules locally where required.

(b) I-S/A AMPE Roles. The I-S/A AMPE program will fill three distinct roles in the mid-term IAS: (1) replacement of AMPEs; (2) replacement of ASCs; and (3) provision of new IAS service.

The I-S/A AMPE program implementation approach reflects these three distinct roles. Accordingly, the following paragraphs present the transition issues relevant to the I-S/A AMPE in each of its projected roles.

(c) AMPE Replacement. Each I-S/A AMPE implementation, enhanced or otherwise, will provide certain basic capabilities that are currently allocated to the AMPE, e.g., journaling, retrieval, intercept, PLA/RI conversion, format and code conversion, and terminal interface. As a minimum, an I-S/A AMPE will function as an AMPE replacement.

The precise configuration of an I-S/A AMPE will vary by location, but will be based on the common family of hardware/ software modules. Unique functions will be accommodated on an "as required" basis.

The lack of AMPE standardization makes it difficult for a subscriber outside the intended community of interest to use an AMPE. The I-S/A AMPE, however, will provide service to all Service/Agency users. Furthermore, R/Y consolidation will be achieved in this network element. Consequently, as the IAS evolves, it is anticipated that the replacement of AMPEs with I-S/A AMPEs will lead to consolidation of AMPE sites and an accompanying reduction in maintenance cost. (See Appendices 2 and 3 for further discussion).

The target date for the first operational I-S/A AMPE (Phase I) is 1982. Subsequent to that milestone all AMPE implementations, new or replacement, will be I-S/A AMPEs. Furthermore, any AMPEs scheduled to be replaced in the six month period immediately preceding introduction of the I-S/A AMPE should be delayed so that they can be replaced by an I-S/A AMPE. By 1990 all current AMPEs will be replaced by the I-S/A AMPE.

The actual AMPE replacement strategy and total I-S/A AMPE requirements will be defined by DCA in coordination with potential Service/Agency users. Nevertheless, certain characteristics of the transition can be stated. These relate to the transition issues of: (1) cutover; (2) AMPE Replacement Strategy; (3) survivability/Availability; (4) overseas Implications; and (5) support Requirements. These transition issues are discussed in the following paragraphs

1. Cutover to I-S/A AMPE. Since continuity of service and user transparency are primary transition objectives, the replacement of an AMPE will require a smooth cutover. Three cutover alternatives are:

a. Alternative 1: Physically install I-S/A AMPE and establish circuits to two higher level elements. Dual connect "back side" AMPE circuits on both AMPE and I-S/A AMPE. Operationally test I-S/A AMPE. Cutover from AMPE to I-S/A AMPE and close down AMPE.

b. Alternative 2: Physically install and home I-S/A AMPE as above. Connect AMPE to back side of IS/A AMPE. Individually cutover back side AMPE circuits. Close down AMPE.

c. Alternative 3: Rehome back side AMPE users to nearby nodes (i.e., PSNs, I-S/A AMPE, or AMPEs). Close down and physically remove AMPE. Install I-S/A AMPE and home to two higher level elements. Re-establish back side users on the I-S/A AMPE.

Alternative 3 significantly impacts other network elements and should be considered only when physical limitations demand AMPE removal prior to I-S/A AMPE installation. Alternative 1 is preferred over Alternative 2 because it allows I-S/A AMPE test and evaluation in a near-operational environment prior to final cutover.

2. AMPE Replacement Strategy. The transition from AMPEs to I-S/A AMPEs will be marked by the incremental addition of I-S/A AMPEs to the network beginning in 1982 primarily based on the remaining useful service life of existing AMPEs. Consequently, the replacement of some AMPEs can be absorbed by I-S/A AMPEs that were fielded for other reasons (i.e., to replace a nearby AMPE or to satisfy new requirements for I-S/A AMPE service). This will happen when an AMPE located close to an operational I-S/A AMPE requires replacement. In this event, AMPE subscribers could be rehomed to the nearby I-S/A AMPE followed by cutover and removal of the AMPE.

3. Survivability/Availability. To enhance survivability and availability, I-S/A AMPEs should be dual homed to two higher level elements; i.e., two PSNs, two I-S/A AMPE(E)s, or one PSN and one I-S/A AMPE(E). As discussed in Section III it is preferable to connect the I-S/A AMPE to a PSN and an I-S/A AMPE(E) in order to facilitate optimum traffic routing and enhanced survivability.

4. Overseas Implications. AMPE equipments located overseas may reach the end of their useful service life and require replacement prior to introduction of I-S/A AMPE(E) service overseas. In this event, homing of replacement I-S/A AMPEs presents two options. The I-S/A AMPEs can be homed to PSNs or CONUS I-S/A AMPE(E)s; however, the use of intercontinental trunks for this purpose is undesirable from both cost and survivability considerations. Alternatively, I-S/A AMPEs could be homed to a remaining overseas ASC via the available AUTODIN I, Mode I interface. This would provide an interim solution until eventual ASC replacement.

5. AMPE Support Requirements. Based on AMPE service life projections and installation schedules,

a significant number of AMPEs will not require replacement in the mid-term time frame and, therefore, must be supported into the far-term.

(d) ASC Replacement. The enhanced I-S/A AMPE(E), a modular expansion of the I-S/A AMPE, will contain AMPE replacement functions and the residual ASC functions e.g., message switching, multiple address routing. Because of the high cost associated with the operation and maintenance of ASCs, a high priority will be placed on phasing out the ASCs. The initial installations of I-S/A AMPE(E)s, projected for early 1985, will be carefully planned so that each installation is accompanied by the closure of an ASC.

Two considerations will be factored into the transition strategy cutover and I-S/A AMPE site selection. In the near-term the number of ASCs in CONUS and Overseas will be reduced. With the implementation of I-S/A AMPEs and additional PSNs, the ASCs will be required only to perform the message processing function for store and forward traffic. It is these functions which the I-S/A AMPE(E) will be designed to perform. Hence elimination of ASCs becomes possible.

1. Overseas ASC Trunking. The primary issue in overseas trunking is maintaining diversity in the event of failures. The preferred connection for trunking is via the PSNs, but additional trunk connections, e.g., O/S I-S/A AMPE(E) to CONUS PSN may be desirable until sufficient PSNs are fielded overseas. Prior to fielding the I-S/A AMPE (E) the ASCs will in some cases maintain their own trunking subnet. When the I-S/A AMPE(E) is fielded, connection between ASCs would be maintained only if PSN connections are found to be insufficient.

2. Rehoming Directly Connected ASC Subscribers. AUTODIN I subscriber terminals that are directly connected to an ASC must be rehomed. Rehoming of terminals will be evaluated on a case-by-case basis. AUTODIN I terminals can be rehomed alternatively to an I-S/A AMPE, or, if a Mode I terminal, to an I-S/A AMPE(E) via PSN transfer. Consideration for each affected terminal should be given to minimizing transmission cost and to the final mid-term IAS configuration. A less attractive rehoming option is to rehome to an AMPE. This would result in another rehoming, however, when that AMPE is phased out. This is inconsistent with planning for a smooth transition.

3. ASC-PSN Connections. CONUS ASCs are connected to the PSN for two purposes: (1) to receive CONUS trunking; and (2) to service message switching requests from remote CONUS subscribers. Once the overseas trunking

and direct subscriber connection problems are resolved, the ASC to PSN connection will only be used for message switching service requests. The PSNs will then route these requests to an I-S/A AMPE(E), thereby resulting in ASC deactivation.

4. Cutover. The actual installation of an I-S/A AMPE(E) is identical in cutover procedures to the installation of an I-S/A AMPE with one exception. That occurs when the I-S/A AMPE(E) is being installed in a location that has an I-S/A AMPE. Those modules necessary to upgrade the system to its enhanced version should be loaded/configured without disrupting the operational system. This is in keeping with continuity of service and user transparency.

5. I-S/A AMPE(E) Site Selection. Cutover transition considerations that should be applied in selecting sites to receive the ASC replacements are discussed in the following subparagraphs.

a. Local Service. I-S/A AMPE(E)s will be deployed as AMPE replacements and/or I-S/A AMPE upgrades and will reside in the access area. They will be dual connected to the PSN backbone using the Mode VI Host interface. I-S/A AMPE(E)s should be sited to minimize transmission costs by taking advantage of the local service implications of the access node and the direct homing potential for nearby AMPEs and I-S/A AMPEs. Consideration should also be given to former ASC sites since these sites may possess needed facilities and support assets that could reduce installation cost.

b. Survivability. Since enhanced survivability is an IAS goal, extra consideration should be accorded to facilities with unique survivability provisions (e.g., hardening, uninterruptable power supply).

c. Expandability. The primary purpose for initial I-S/A AMPE(E) installations is to facilitate ASC phaseout. Consequently, the primary emphasis during planning stages will be to identify those I-S/A AMPE(E) sites that will permit ASC closings. Requirements for I-S/A AMPE(E) service can be satisfied by upgrading I-S/A AMPE sites.

(e) New Services. As currently projected, requirements for new network services such as mailbox and teleconferencing will be satisfied through modular expansion of the I-S/A AMPE(E). The modular implementation of these services offers a great deal of flexibility in configuring I-S/A AMPE(E)s to provide these services. As an extreme,

these modules could be configured on a network element other than an I-S/A AMPE(E) (e.g., to provide backup capability). Requirements for these modules will be evaluated on a case-by-case basis.

(2) Expansion of Packet Switch Node (PSN) Backbone. The mid-term IAS will mark the emergence of a worldwide data backbone. PSNs will be deployed in both CONUS and overseas to augment the near-term eleven node network. As the data backbone evolves, transition objectives and issues take on the following significance.

(a) PSN Expansion - Sequence of Events. It is undesirable to execute a transition step that will be reversed by subsequent transition steps. In this regard, each step of the transition should reflect as closely as possible the final mid-term configuration. In this context, requirements for PSNs should be identified during planning stages through consideration of the deployment of other mid-term network elements, specifically, the I-S/A AMPE, I-S/A AMPE(E) and CFT. The installation of PSNs should be closely coordinated with the schedules for the other elements so that PSNs are fielded first. This will facilitate a smooth transition by eliminating needless iterative rehoming of subscriber equipment and access nodes. Rehoming is unavoidable in an evolving network, but it can be kept to a minimum through careful transition planning.

(b) Overseas PSN Implications. As enhanced survivability is a system objective, consideration should be given to deploying smaller, more mobile PSNs overseas. Implementation of the PSN Terminal Access Control functions in the I-S/A AMPEs should facilitate a smaller PSN configuration.

(3) Common Family of Terminals. The mid-term IAS will be required to support a mix of subscriber terminals that fall into one of the following categories: (1) AUTODIN I Terminals; (2) AUTODIN II Terminals; (3) AUTODIN II Host; and (4) Common Family of AUTODIN Terminals. As the IAS evolves, the distinction between these different categories of terminals will disappear as the Common Family of Terminals will satisfy subscriber requirements. Beginning in 1984, the common family of terminals will be used to fulfill needs for new or replacement subscriber equipment. All categories of equipments are expected to exist through the mid-term. Depending on the service needs of the subscriber, terminals will be terminated on AMPEs, I-S/A AMPE, I-S/A AMPE(E)s, or PSNs. Table 10 shows the termination alternatives available to a subscriber. Also, with the I-S/A AMPE(E) located in

TABLE 10

MID-TERM IAS TERMINATIONS

		Terminating Device			
Network Component		AMPE	PSN	I-S/A AMPE	I-S/A AMPE(E)
TERMINAL	AUTODIN I	Yes	Yes*	Yes	Yes
	AUTODIN II	No	Yes	Yes	Yes
	AUTODIN II (Host)	No	Yes	TBE	TBE
	Common Family of Terminals	No	Yes	Yes	Yes

* Mode I only, (terminated to PSN but homed to I-S/A AMPE(E))

TBE--To Be Evaluated

the access area, dual homing may be employed for those programmable terminals capable of selecting the best path relative to the service desired. Such terminals would be dual homed to a PSN and an I-S/A AMPE(E).

(4) Integration Of Security Components. The mid-term IAS will feature the introduction of an end-to-end encryption (E^3) capability. This capability will be based on the use of BLACKER hardware and software components. Transition considerations for these elements are provided in a separate classified appendix (Appendix 4).

(5) Milestones and Schedule. The overall strategy for transitioning from the near-term to the mid-term IAS can be postulated in terms of sequence of events, target dates, and the interdependencies of events. The transition considerations discussed in the preceding paragraphs have been factored into a recommended transition plan as shown in Table 11 and Figure 25. Table 11 lists the required activities and their associated target dates in chronological order. Figure 25 presents these activities as a milestone chart. The transition strategy is a feasible approach to achieving the mid-term IAS in a deliberate and continuous manner. It also provides the framework for more detailed network element transition plans.

4. Far-Term IAS.

a. Elements. The far-term IAS is defined as a third generation (Post 1988) integrated data communications system to be developed in conjunction with the other third generation (DCS III) subsystems. These interrelated DCS subsystems include Automatic Voice Network (AUTOVON), Automatic Secure Voice Communications (AUTOSEVOCOM), the IAS, The Defense Satellite Communications System (DSCS), and the Automated Technical Control (ATEC) System. The far-term architecture elements should proceed initially from the near to mid-term system architecture and should include the AUTODIN II PSNs, the I-S/A AMPEs and the common family of AMPE remote and AUTODIN terminals. The terrestial switched and broadcast satellite architecture alternatives for the far-term IAS, along with the identification of major network elements, are described in Section IV of the IASA Report (Part 1).

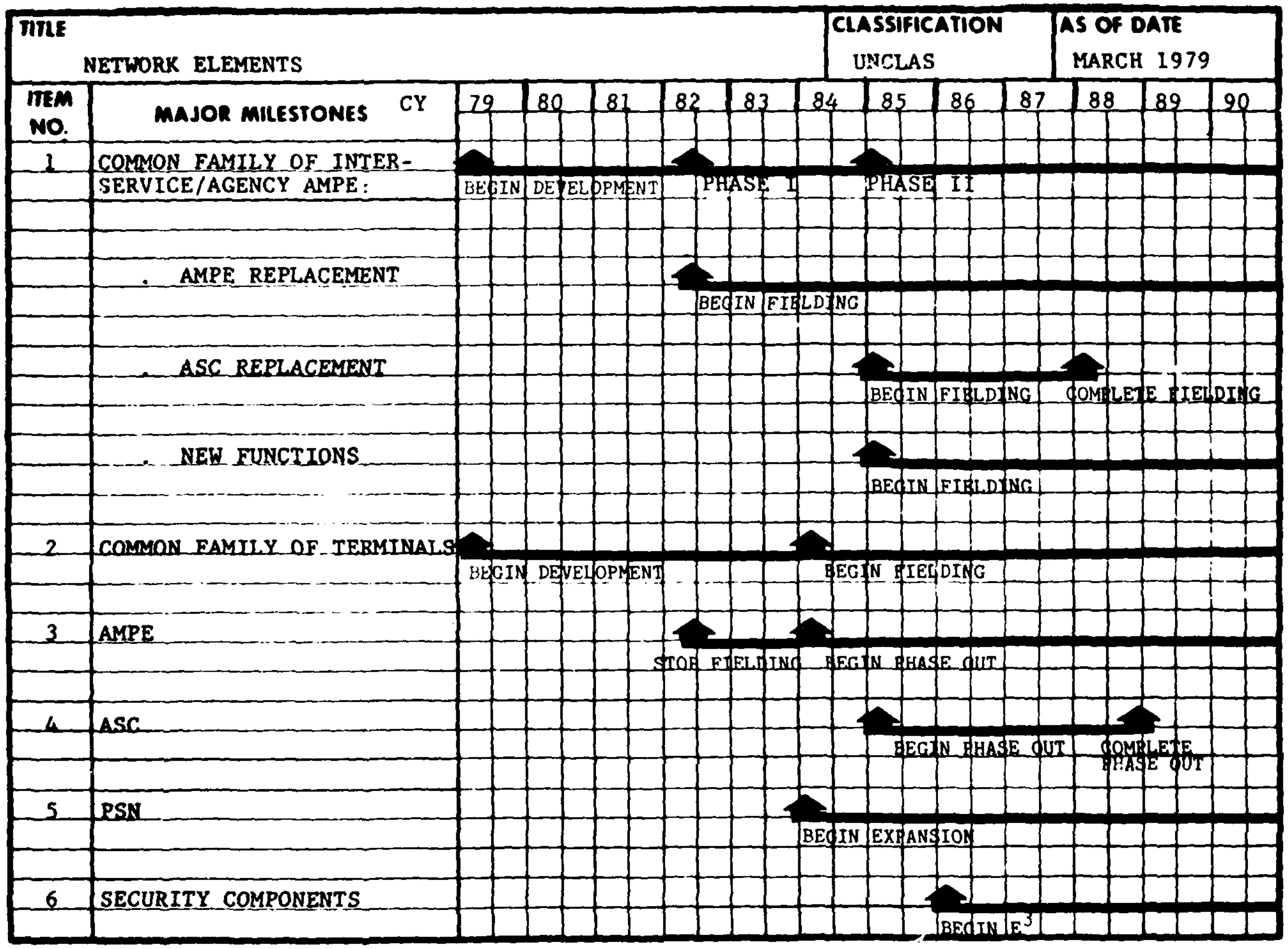
b. Transition Strategy. The far-term DCS, to include the IAS, should evolve from the near and mid-term architecture approaches. The functional allocation scheme,

TABLE 11

MID-TERM IAS TRANSITION PLAN

	Activity	CY Target Date
a.	Start Development of I-S/A AMPE Family of Nodes	1979
b.	Start Development of Common Family of Terminals	1979
c.	Start Mid-Term Topology Design & Related Studies	1979
d.	Start Development of New Services and Functions	1980
e.	Detailed Definition of Functions for I-S/A AMPE	1980
f.	HOL Decision (DoD)	1981
g.	Begin Development of HOL Software for I-S/A AMPE	1981
h.	Mid-Term IAS System Implementation Plan Development	1981
i.	Definition of Services and Functions for I-S/A AMPE	1982
j.	Begin Fielding I-S/A AMPE (Phase I)	1982
k.	Begin PSN Expansion (O/S and CONUS as required)	1984
l.	Begin Fielding Common Family of Terminals	1984
m.	Begin AMPE Phaseout (Phase II)	1984
n.	Begin Fielding I-S/A AMPE (E) (Phase II)	1985
o.	Begin Phaseout of Remaining ASCs	1985
p.	Begin Fielding End-to-End Encryption Equipment	1986
q.	Complete Phaseout of O/S ASCs	1987

s.	Complete Phaseout of CONUS ASCs	1988
t.	Mid-Term IAS Architecture Achieved	1988
u.	Complete AMPE Phaseout	1990



MID-TERM IAS MILESTONES
FIGURE 25

illustrated in Figure 16, should continue into the far-term IAS. In addition, the projected Service/Agency AMPE replacement requirements, identified in Appendix 2, Table 13, will influence the extent of I-S/A AMPE implementation into the far-term IAS. End-to-end encryption should be an integral part of the far-term IAS.

(1) The DCS, which provides common-user switched services and long-haul transmission backbone for defense communication needs, has started to convert from an analog to a digital based capability. Evolutionary planning of near through far-term DCS common user record and data communications is proceeding under the IASA project and will evolve into the far-term DCS. Transmission facilities are being tailored to support an extensive digital, second-generation secure voice capability, while later stages of the fully, integrated digital DCS architecture should support a much broader World Wide Digital System Architecture (WWDSA). Defining this integrated digital system is an ongoing DCA task, results to be promulgated in future DCS plans.

(2) The feasible union of AUTOSEVOCOM and AUTOVON services will be evident as AUTOVON becomes the primary carrier for secure voice services. The Secure Voice Improvement Program (SVIP) should introduce a secure voice terminal to replace the AUTOVON four-wire stations. AUTOVON itself will change in an evolutionary manner exploiting developments in commercial telephony, and it may later become the vehicle for economically providing interswitch trunks and access lines for the AUTODIN network.

(3) The IAS components to include PSNs, I-S/A AMPEs and subscriber terminals will make maximum use of the throughput capability and efficiencies of digital data trunks and access lines coupled with exploitation of packet switching technology.

(4) In transmission, the use of Pulse Code Modulation/Time Division Multiplexing (PCM/TDM) should exploit the advantages of end-to-end digital operation without the use of wireline modems, although this will be a very gradual process. In line with the probable far-term satellite broadcast architecture for the IAS, exploitation of access advantages in satellite operation with small satellite terminals near customer premises should exist in the mid to far-term (post 1988) time frame.

(5) The integration of transmission and circuit switching accompanied by the on-going removal of channel banks, associated patching, testing, and distribution frames should offer increased potential for reducing annual recurring costs in the far-term DCS. For instance, the use of commercial circuit switches as automatic patching and wiring facilities should make it possible to carry special purpose networks as "dedicated time slots" carrying special traveling class marks.

(6) Figure 26 illustrates a far-term (post 1988) transition approach. As shown, through evolution the various subsystems should become an integrated voice/data system based on digital technology and end-to-end encryption.

5. Integrated AUTODIN System (IAS) RDT&E. Significant DCA and Service/Agency Research, Development, Test and Evaluation (RDT&E) will be required to meet the user demands for improved service at reduced costs.

a. The major RDT&E requirements are:

(1) Prepare IAS interface standards, protocols, and operating procedures.

(2) Develop, test, and evaluate the common family of AUTODIN terminals.

(3) Develop the Higher Order Language (HOL) and an overall Software Engineering System.

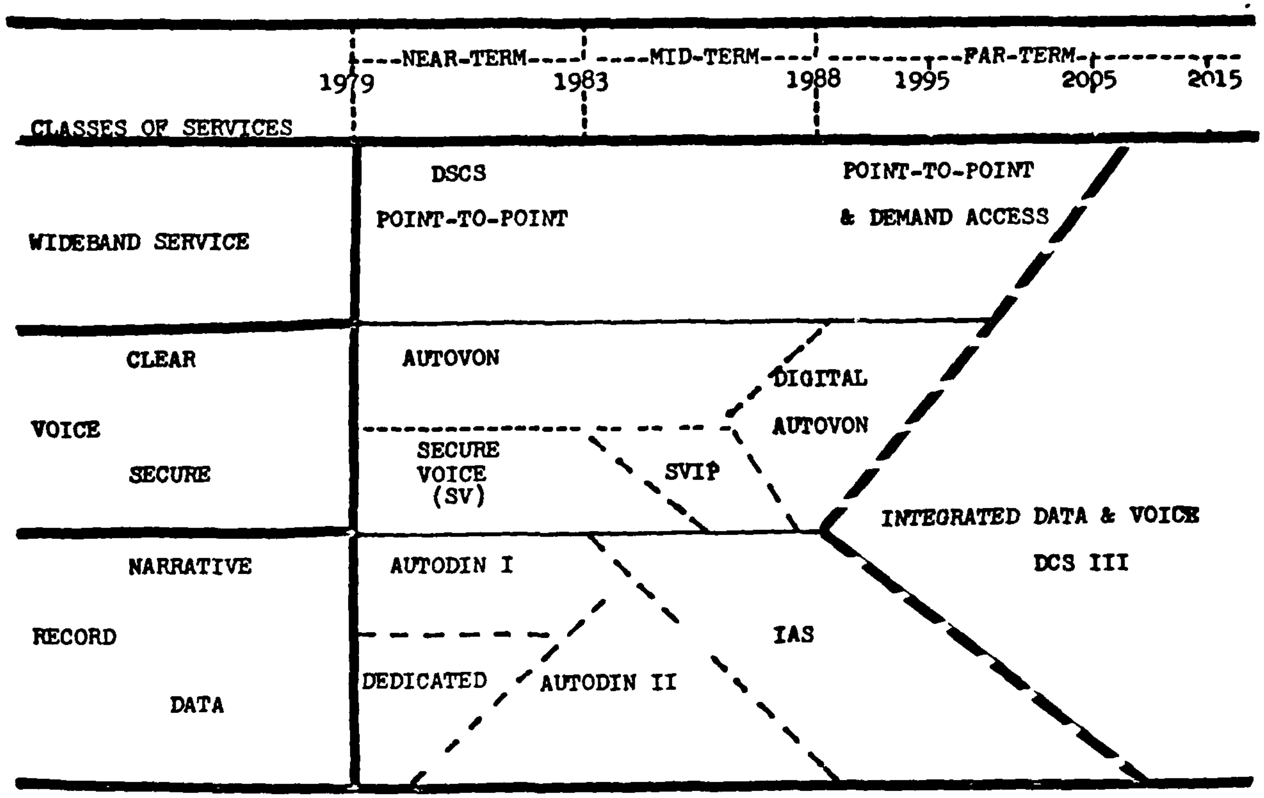
(4) Complete the Network Security Analysis.

(5) Develop, test, and evaluate the basic and enhanced I-S/A AMPE.

(6) Establish and evaluate "pilot" services including gateway functions.

(7) Develop long range IAS Architecture in the context of the future integrated DCS design and concepts.

b. Reference is made to Table 12 for a summary of IAS RDT&E funds for the period FY 1977-1985.



FAR-TERM TRANSITION STRATEGY

FIGURE 26

TABLE 12

IAS RDT&E FUNDS SUMMARY

(TABLE DELETED)

SECTION V

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

A. *Conclusions*.

1. The previous sections to this IASA project report have presented a picture of the AUTODIN system from the perspective of mid-term, 1984-1988, architectural alternatives. This report identified alternative architectures for the mid-term and described the process and rationale for selecting the preferred (Alternative II) architecture. Based upon user requirements and the need to provide more efficient common-user AUTODIN service, a transition strategy has been provided from today's AUTODIN capabilities to the circa 1990 Integrated AUTODIN System.

2. The overall objective of the IASA project is to design and engineer a system based upon AUTODIN I and AUTODIN II, which is complete and integrated from end to end. The IASA design is by necessity evolutionary in development, with the key ingredient being responsiveness to user needs. In meeting this objective, the IASA project has logically been divided into three parts. The December 1977 IASA Report (Part 1) provided AUTODIN implementation alternatives and recommendations through 1983. This report (Part 2) provides architectural alternatives for the period 1984 through 1988. In October 1979 an IASA (Part 3) report will be provided to include standards and functional specifications for a common family of terminals.

3. The conclusions presented in the IASA Report (Part 1) remain valid. The AUTODIN terminal-to-terminal analysis presented in this Part 2 report has resulted in the following conclusions:

a. The near-term (1979-1983) IAS architecture should provide an AUTODIN system that is responsive to the needs of both narrative/record and data users. On the other hand, the 1983 IAS does not represent an acceptable conclusion to the integration process.

b. There is need for continued evolution to a mid-term Integrated AUTODIN System Architecture.

c. The roles and relationships of components of the IAS are identified to include AUTODIN I, AUTODIN II, AMPEs, I-S/A AMPEs, and the common family of terminals.

d. The 1983 IAS should consist of eleven to fifteen AUTODIN I switching centers (four to eight in CONUS and seven overseas), and eleven AUTODIN II packet switching nodes (eight in CONUS and three overseas).

e. The 1983 IAS represents an increase in standardization of AMPE and terminal operation/configuration through introduction of Inter-Service/Agency AMPEs.

f. Enroute to developing functional specifications for a common family of terminals a joint Service/Agency teletypewriter replacement program has been established.

g. Interoperability to tactical and NATO forces will be enhanced through their direct standard connections to AUTODIN elements.

h. The 1983 IAS represents improvement in cost effectiveness as a result of the closure of one or more ASCs and consolidation of ASC and PSN sites.

i. The IAS security subsystem will satisfy three basic requirements: (1) provide a transparent, secure switching/transmission system for subscribers using the IAS as a basic communications backbone; (2) provide subscribers secure special network services; and (3) provide reliable security services with minimum life cycle costs. Additional conclusions in the area of security are provided in the classified Appendix 4.

j. The DoD Automated Message Handling Systems (AMHS) plan states the IASA project is the means whereby telecommunications AMHS objectives are achieved.

k. Eighty telecommunications functions have been identified and allocated to the elements of the mid-term IAS Architecture consisting of terminals and nodal facilities.

l. A DoD standard DD Form 173 Joint Messageform has been developed and approved by the Military Communications-Electronics Board (MCEB) with mandatory implementation by 1 January 1980.

m. A staffing standard for manual and semi-automated telecommunications centers has been developed and forwarded to ASD/C^3I for approval and implementation.

n. For the mid-term three alternative architecture configurations have been evaluated and compared based upon

e criteria of operational effectiveness, flexibility, survivability/availability/supportability, transition and cost. As a result of this analysis, the preferred architecture for the mid-term IAS should be based upon a distributed architecture (Alternative II), whereby services are provided from a common access area element. The major elements of the architecture are the AUTODIN II PSNs, the Inter-Service/Agency (I-S/A) AMPEs and subscriber terminals. This architectural structure moves switching functions closer to the user by use of the enhanced I-S/A AMPE, and in consonance with recent planning efforts for DCS architectures, it will reduce the dependency on the more vulnerable backbone switches and should enhance overall survivability.

o. The mid-term transition strategy is driven by the following architectual objectives: (1) preserve continuity of existing network services; (2) provide for needed new services; (3) enhance system survivability; (4) enhance tactical and allied forces interoperability; and (5) replace obsolete equipment with new or augmented standard network elements.

p. The Inter-Service/Agency (I-S/A) AMPE will be used to satisfy all requirements for new or replacement AMPEs. An enhanced version of this network element, the I-S/A AMPE(E), in addition to providing AMPE functions and services, will assume the functional role of the near-term ASC and will provide network services currently outside the scope of the near-term system.

q. The preferred architecture:

(1) is consistent with the mid-term IAS objectives and is capable of providing all of the identified services and functions;

(2) offers significant opportunity for reduction in O&M cost through standardization of Service/Agency message processing and communications hardware, software and operation procedures.

(3) provides the improved access reliability for users through multiple interconnection of network access nodes;

(4) permits the introduction of significant new telecommunication services and features;

(5) permits improved speed of service and

overall increased network responsiveness to user needs;

(6) provides the flexibility needed to allow the mid-term AUTODIN system to accommodate many unique user requirements without penalty to other users;

(7) can be implemented in a smooth evolutionary process from the near-term 1983 architecture and provides the framework for continued evolutionary development of the IAS through 1988 and beyond.

B. Recommendations.

1. The recommendations presented in the IASA Report (Part 1) remain valid and steps have been taken to implement these actions. For example, based on our recommendation, ASD/C^3I directed the DCA to establish an I-S/A AMPE program. This program has since been defined with appropriate milestones to implement the first I-S/A AMPE element in 1982.

2. As a result of efforts to identify, correlate, and project the Services/Agencies AUTODIN mid-term (1984-1988) requirements, the following recommendations are that:

a. Alternative II architecture be approved for implementation.

b. Services/Agencies be active participants in defining telecommunications requirements and developing functional specifications for the common family of terminals, to include the I-S/A AMPE.

c. Services/Agencies identify requirements for AUTODIN II service overseas.

d. The IASA Project Office monitor the MCEB development of a joint Plain Language Address Directory and a message delivery system for AUTODIN terminals as opposed to initiating parallel development efforts.

e. Services/Agencies maintain close coordination with DCA on the physical consolidation of Special Intelligence and General Service telecommunications centers. This contact should insure requirements and lessons learned are factored into the I-S/A AMPE program.

f. Analysis be performed to determine personnel overhead requirements to manage the IAS implementation. This analysis should include software development/maintenance, logistics support, training and program management.

APPENDIX 1

ACRONYMS

APPENDIX 1

ACRONYMS

A

ACP	-	Allied Communications Publication
ADP	-	Automatic Data Processing
ALPS	-	AUTODIN Limited Privacy Service
AF AMPE	-	Air Force AMPE
AMHS	-	Automated Message Handling System
AMME	-	Automated Multi-Media Exchange
AMPE	-	Automated Message Processing Exchange
ARPA	-	Advanced Research Projects Agency
ARPANET	-	Advanced Research Projects Agency Network
ASC	-	AUTODIN Switching Center
ASCII	-	American Standard Code for Information Inter-Change
ASD/C^3I (ASD/CCCI)	-	Assistant Secretary of Defense/Command Control Communications and Intelligence
ATEC	-	Automated Technical Control
ATP	-	Automated Telecommunications Program
AUTOSEVOCOM	-	Automatic Secure Voice Communications
AUTODIN	-	Automatic Digital Network

B

BSL	-	Binary Segment Leader
BCR	-	BLACK-CRYPTO-RED
BDT	-	Bulk Data Transfer

C

CC	-	Crypto Concentrator

CCU	-	Common Control Unit
CFT	-	Common Family of Terminals
CINCPAC	-	Commander-in-Chief Pacific
CINCEUR	-	Commander-in-Chief Europe
COMSEC	-	Communications Security
CONUS	-	Continental United States
CSF	-	Central Service Facility

D

DARPA	-	Defense Advanced Research Projects Agency
DCA	-	Defense Communications AGency
DCEC	-	Defense Communications Engineering Center
DEMO	-	Demonstration
DLA	-	Defense Logistics Agency
DODIIS	-	Department of Defense Information Intelligence System
DSCS	-	Defense Satellite Communications System
DSSCS	-	Defense Special Security Communications System
DSTE	-	Digital Subscriber Terminal Equipment
DTACCS	-	Director Telecommunications and Command and Control Communications System

E

E^3	-	End-to-End Encryption
EUCOM	-	European Command

F

FACC	-	Ford Aerospace and Communications Corporation
FKV	-	Frankfurt-Koenigstuhl-Vaihingen

FYP	-	Five Year Program

G

GAO	-	Government Accounting Office
GENSER	-	General Service
GFE	-	Government Furnished Equipment

H

HAC	-	House Appropriations Committee
HOL	-	High Order Language

I

I/A	-	Interactive
IAS	-	Integrated AUTODIN System
IASA	-	Integrated AUTODIN System Architecture
IMP	-	Interface Message Processor
IOC	-	Initial Operational Capability
IRT	-	Interim Remote Terminal
I-S/A AMPE	-	Inter-Service/Agency Automated Message Processing Exchange
I-S/A AMPE(E)	-	Inter-Service/Agency AMPE (Enhanced)

J

JANAP	-	Joint Army Navy Air Force Publication
JCS	-	Joint Chiefs of Staff

K

Kbits	-	Kilobits
kbs or Kbps	-	Kilobits per second
KD	-	Key Distribution
KDC	-	Key Distribution Center

	KG	- Key Generator
	KGU	- Key Generating Unit
	KSOS	- Kernelized Security Operating System
<u>L</u>		
	LCM	- Line Control Module
	LDMX	- Local Digital Message Exchange
	LSI	- Large Scale Integration
<u>M</u>		
	MCCU	- Multiple Channel Control Unit
	MCEB	- Military Communications-Electronics Board
	MILDEPS	- Military Departments
	MIL-STD	- Military Standard
	MLS	- Multi-level Security
	MOP	- Memorandum of Policy
	MRTT	- Modular Record Traffic Terminal
	MTBF	- Mean Time Between Failure
	MTCC	- Modular Tactical Communication Center
	MULTICS	- Multiplexer Information and Computing Service
<u>N</u>		
	NATO	- North Atlantic Treaty Organization
	NAVCOMPARS	- Naval Communications Processing and Routing System
	NCC	- Network Control Center
	NFE	- Network Front End
	NICS	- Nato Integrated Communications System
	NIDS	- NMCC Information and Display System

NMCC	- National Military Command Center
NMIC-SS	- National Military Intelligence Center Support Subsystem

O

OCR	- Optical Character Reader
OJCS	- Office of Joint Chiefs of Staff
O/S	- Overseas
OSD	- Office of the Secretary of Defense

P

PAC	- Pacific
PACOM	- Pacific Command
PCM	- Pulse Code Modulation
PLA-RI	- Plain Language Addressing - Routing Indicator
PLAD	- Plain Language Address Directory
PLI	- Private Line Interface
PSN	- Packet Switch Node

Q

Q/R	- Query Response

R

R&D	- Research and Developement
RDT&E	- Research Development Test and Evaluation
RI	- Routing Indicator
R/Y	- Code used in TCC Operations for GENSER/ DSSCS Operations

S

SACDIN	- Strategic Air Command Automatic Digital Network

SCCU - Single Channel Control Unit

SCI - Sensitive Compartmented Information

SCM - Switch Control Module

SDC - Software Development Corporation

SNFE - Secure Network Front End

SIP - Segment Interface Protocol

SRI - Stanford Research Institute

SRT - Standard Remote Terminal

SST - Single Subscriber Terminal

SV - Secure Voice

SVIP - Secure Voice Improvement Program

<u>T</u>

TAC - Terminal Access Control

TARE - Teletypewriter Automated Relay Equipment

TCC - Telecommunications Centers

TCP - Transmission Control Program

TDM - Time Division Multiplexing

THP - Terminal to Host Protocol

TRI-TAC - Joint Tactical Communications Office

<u>U</u>

UCLA - University of California at Los Angeles

<u>V</u>

VAN - Value Added Network

VM - Virtual Machine

VMP - Virtual Message Protocol

W

WIN	-	WWMCCS Intercomputer Network
WWMCCS	-	World-wide Military Command and Control System

APPENDIX 2

AMPE AND INTER-SERVICE/AGENCY AMPE

REQUIREMENTS (1982-1990)

APPENDIX 2

AMPE AND INTER-SERVICE/AGENCY AMPE

REQUIREMENTS (1982-1990)

A. Purpose. The purpose of this appendix is to analyze the projected requirements for the AMPE and Inter-Service/Agency Automated Message Processing Exchange (I-S/A AMPE) as an input to the mid-term IAS architecture. This appendix also includes development of AMPE replacement strategy. The analysis and the projections presented herein are for planning purposes only. Detailed site by site implementation plans remain to be developed.

B. Assumptions. The assumptions that form the basis for the following analysis are:

1. A standard AMPE for Inter-Service/Agency use will be available in 1982.

2. The projected AMPE population by 1983 should be 109 broken down as follows:

Service/Agency	Number of AMPEs
Navy	20
Army	19
Air Force	20
NSA	31
DLA	19
Total	109

The analysis assumes that Army and Navy projected AMPE installations through 1982 should proceed as planned. Air Force projected AMPE requirements through 1981 should be deployed using their AF AMPE, with projected requirements for 1982 and beyond satisfied by I-S/A AMPEs.

3. Existing DLA AMPEs (fielded in the early 1970s) should be replaced between 1982 and 1984 using the I-S/A AMPEs.

4. The service life of all current AMPEs is estimated at eight to ten years.

5. AMPE requirements identified for the period 1978-1982 indicate a growth in AMPE population of 8% to 9% per year.

6. A four percent rate of growth is projected for I-S/A AMPEs beginning in 1982; one fourth of that rate of growth should be absorbed through AMPE consolidations on I-S/A AMPEs and the remaining three fourths should be satisfied by new I-S/A AMPE installations.

7. All NSA STREAMLINER AMPEs should be replaced between 1985 and 1987 based on their fielding dates (1977-1978) and assumed service life.

8. LDMX-I systems (single 70/45 processor) should be replaced in the 1985-1987 time frame based on service life.

9. AMPEs within 50 miles of each other should be replaced by a single I-S/A AMPE or by two I-S/A AMPEs if more than three AMPEs are involved. Otherwise, replacement of AMPEs by I-S/A AMPEs should be on a one-for-one basis.

10. AMPE testbed facilities should remain in place as long as any AMPEs of the corresponding Service or Agency are still in the field.

C. Analysis.

1. A total of 109 AMPEs are currently projected to be in place by the end of 1982, thirty-one of which are NSA STREAMLINER systems. An analysis of the AMPEs was performed on a case by case basis from which replacement dates and consolidation strategies were developed. The results of the analysis are presented in Table 13. The 78 projected AMPEs belonging to Army, Navy, Air Force, and DLA are listed by geographical location. Also shown is the time frame in which each AMPE should be replaced along with potential consolidation.

2. Additional notes related to Table 13 are:

- STREAMLINER locations are CONFIDENTIAL and are therefore not listed.

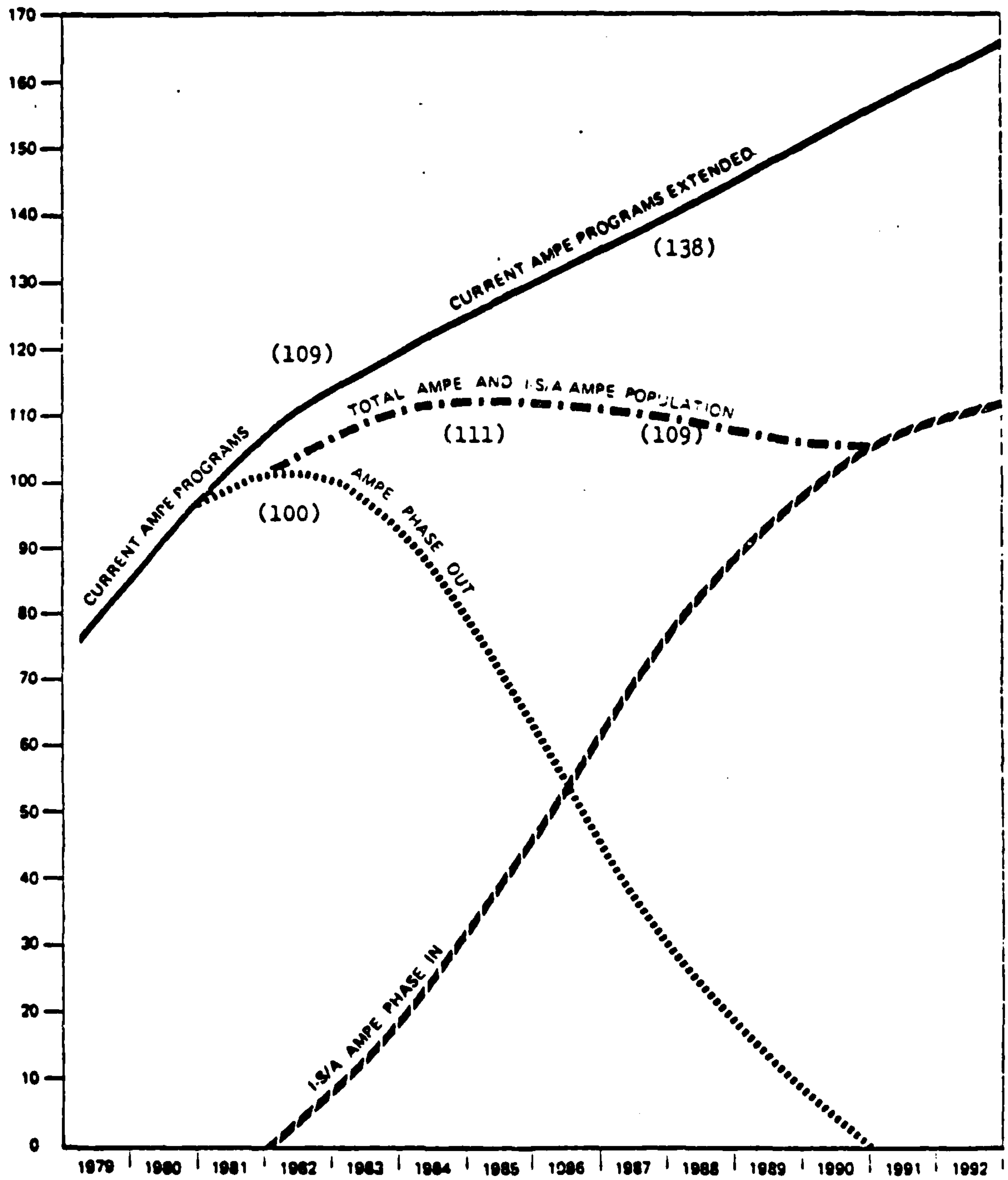
- Army AMPEs that are not already in place have the projected installation date listed along with the location name.

- Navy AMPEs are identified by system type (LDMX or NAVCOMPARS) and generation (I or II). Those that are not yet in place have the projected installation date listed.

. Eleven of the Air Force AMPE locations are labled "NEW". These represent 1982 and delayed 1981 requirements (Assumption 2) that should be satisfied by I-S/A AMPE rather than the current AF AMPE program. Seven of the requirements are met via consolidation on I-S/A AMPEs installed to replace one Navy and three DLA locations.

3. The population of AMPEs and I-S/A AMPEs through the mid-term and into the far-term IAS can be derived from Table 13. These figures are shown numerically in Table 14 and graphically in Figure 27. Although NSA AMPE locations are not listed in Table 13, an analysis of these locations indicated that eight sites could potentially be consolidated with other Inter-Service/Agency AMPEs with the remaining twenty-three sites replaced by I-S/A AMPEs. These have been included in the net increase of 36 replacement I-S/A AMPEs shown for the 1985-1987 time frame in Table 14.

D. Conclusions. Without the I-S/A AMPE program and consolidation of AMPE sites, the number of AMPEs should exceed 150 by 1990 based on the projected rate of growth. The I-S/A AMPE program, with 106 I-S/A AMPEs in 1990, represents a potential 34% savings in the number of elements.



PROJECTED AMPE/I-S/A AMPE REQUIREMENTS
FIGURE 27

TABLE 13

PROJECTED AMPE AND I-S/A AMPE REQUIREMENTS, BY LOCATION

ID	I-S/A AMPE LOCATION	REPLACED AMPE	OWNED BY	NO. OF I-S/A AMPEs
1	Alabama, Huntsville	Huntsville	A	1
2	Arizona, Sierra Vista	Ft. Huachuca	A	0 (Test Bed)
3	California, Los Angeles	Los Angeles	DLA	1
4	Oakland	Lakland	A	1
5	Sacramento	Sacramento	A	
		McClellan AFT	AF	1
		Travis AFB	AF	
6	San Diego	San Diego	N	1
		North Island	N	
7	Stockton	Stockton	N	1
		Tracy	DLA	
8	Colorado, Colorado Springs	Ent AFB	AF	1
9	Denver	Lowry AFB	AF	1
10	England, London	London	N	1
11	Europe, Unknown	Unknown	A	1
12	Florida, Jacksonville	Jacksonville	N	1
13	Tampa	MacDill AFB	AF	1
14	Valparaiso	Eglin AFB (New)	AF	1

TABLE 13

PROJECTED AMPE AND I-S/A AMPE REQUIREMENTS, BY LOCATION (CONTINUED)

15	Georgia, Atlanta	Atlanta	A	1
		Atlanta	DLA	
16	Macon	Robins AFB	AF	1
17	Germany, Frankfurt	Frankfurt	A	1
18	Heidelberg	Heidelberg	A	1
19	Stuttgart	Stuttgart	A	1
20	Ramstein AFB	Ramstein AFB	AF	1
21	Guam	Guam	N	1
22	Hawaii, Oahu	Camp Smith	N	2
		Hickam AFB	AF	
		Honolulu	N	
		Makalaka	N	
23	Illinois, Chicago	Chicago	DLA	1
24	Rock Island	Rock Island	A	1
25	Japan, Yokota	Yokota	AF	1
26	Italy, Naples	Naples	N	1
27	Kansas, Kansas City	Ft. Leavenworth	A	1
28	Korea, Taegu	Taegu	A	1

TABLE 13

PROJECTED AMPE AND I-S/A AMPE REQUIREMENTS, BY LOCATION (CONTINUED)

29	Louisiana, New Orleans	New Orleans	N	1
30	Maryland, Baltimore	Baltimore	A	1
31	Massachusetts, Boston	Boston	DLA	1
32	Michigan, Battle Creek	Battle Creek	DLA	1
33	Missouri, St. Louis	St. Louis	A	
		St. Louis	DLA	1
		Scott AFB, Ill.	AF	
34	Not used			
35	New Jersey, Ft. Monmouth	Ft. Monmouth	A	
		McGuire AFB	AF	1
		New York City, N.Y.	DLA	
36	North Carolina, Camp Lejeune	Camp Lejeune	N	1
37	Ohio, Dayton	Wright-Patterson AFB	AF	1
		Gentile	DLA	
38	Cleveland	Cleveland	DLA	1
39	Columbus	Columbus	DLA	1
40	Oklahoma, Oklahoma City	Tinker AFB (Test Bed)	AF	0 (Test Bed)
41	Oklahoma City	Tinker AFB	AF	1

TABLE 13

PROJECTED AMPE AND I-S/A AMPE REQUIREMENTS, BY LOCATION (CONTINUED)

42	Pennsylvania	Letterkenny	A	1
		Mechanicsburg	DLA	
43	Philadelphia	N. Philadelphia	DLA	1
		S. Philadelphia	DLA	
44	Philippines	Clark AFB (1980)	AF	1
45	Puerto Rico	Roosevelt Roads	N	
46	South Carolina, Charleston	Charleston	N	1
47	Tennessee, Memphis	Memphis	DLA	1
48	Texas, Dallas	Dallas	DLA	1
49	San Antonio	Kelly AFB (New)	AF	1
		Randolph AFB (New)	AF	
50	El Pasc	Ft. Bliss (1981)	A	1
51	Utah, Ogden	Ogden	DLA	1
		Hill AFB	AF	
52	Virginia, Norfolk	Breezy Point	N	2
		Hampton Roads	N	
		Langley AFB	AF	
		LANT	N	
53	Richmond	Richmond	DLA	1

TABLE 13

PROJECTED AMPE AND I-S/A AMPE REQUIREMENTS, BY LOCATION (CONTINUED)

54	Washington, Puget Sound	Puget Sound	N	1
55	Washington, D.C.	Cheltanham, Maryland (Test Bed)	N	0 (Test Bed)
		Alexandria, Virginia	A	
		Baileys Crossroads, Virginia	A	
		Cameron Station, Virginia	DLA	3
		Crystal Plaza, Virginia	N	
		Pentagon	A	

TABLE 14

PROJECTED AMPE AND I-S/A AMPE REQUIREMENTS, BY SERVICE/AGENCY

NUMBER OF AMPEs	1981	(CHANGE)	1984	(CHANGE)	1987	(CHANGE)	1990
NAVY	20	-3	19*	-10	9	- 9	0
ARMY	19	-1	18	- 6	12	-12	0
AIR FORCE	11	0	11	- 1	10	-10	0
NSA	31	0	31	-31	0	0	0
DLA	19	-19	0	0	0	0	0
Total AMPEs	100	23	79	48	31	31	0
Replacement I-S/A AMPEs		+21 21		+36 57		+18 75	
New I-S/A AMPEs		+11 11		+10 21		+10 31	
Total I-S/A AMPEs			32		78		106
Total AMPEs & I-S/A AMPEs			111		109		106

*Two LDMX installations are projected for 1982
Thus: 20 + 2 LDMXs -3 replacements = 19

APPENDIX 3

COST ANALYSIS

APPENDIX 3

COST ANALYSIS

A. Introduction.

1. Purpose. The purpose of this appendix is to describe the major aspects and results of a comparative cost analysis performed in support of the mid-term IAS architecture definition effort. The analysis focused on two objectives: comparative evaluation of candidate mid-term architectures, and comparison between the preferred mid-term alternative and the baseline architecture projected to the mid-term.

2. Background. A few preliminary observations are in order. First, the analysis of alternatives is comparative. Therefore, costs common to all of the alternatives have been excluded in order to simplify the analysis. Secondly, the analysis seeks to select a least-cost alternative without resorting to an exhaustive life-cycle cost effort which would require detailed information on implementation strategy. Therefore, the analysis is limited to the level of detail necessary to the identification of trends and projections which provide an adequate basis for relative cost comparison and ranking among alternatives.

3. Approach. The basic approach to the cost analysis consists of the following steps:

a. Identification and analysis of major cost elements. From a complete list of elements, only those found to be dependent upon network architecture have been retained. These are transmission cost, nodal element acquisition cost, and nodal element operation and maintenance cost.

b. Identification of architecture dependent cost factors within each cost element. Again, costs which are common to all three architectures have been discarded.

c. Development of cost estimating relationships or costing methods for each cost factor. In cases where a mathematical expression is not applicable or is difficult to obtain, a costing method has been developed which produces the cost value for given parameter values.

d. Evaluation of architecture dependent cost factors. The cost factors are evaluated using nominal parameter values.

e. Sensitivity analysis. Parameters and assumptions are varied and the impact on cost is assessed. Those which drive the total cost are identified.

f. Accumulation of cost factors and ranking of alternatives. The cost factors within each major cost element are evaluated and aggregated into a total element cost. The total cost, together with sensitivity and other considerations, is used to rank the alternatives.

g. Overall cost ranking of alternatives. The results associated with each major cost element are combined into a final ranking. The relative weights of the cost elements are factored into this evaluation process.

4. Assumptions. Additional general assumptions and ground rules that support the cost analysis are presented below.

a. The number of subscriber terminals and host computers in the system is independent of the architectural alternative. This cost component has been excluded from the comparative analysis.

b. For simplicity, the cost impact of certain architectural issues was not factored into the analysis. Prime examples are security and system management and control. These issues were, however, addressed under various technical criteria.

c. Within each major cost element the analysis focused on those cost factors which contribute the most to total cost. Items subordinate to these primary factors will, in general, follow the primary factors and only increase the magnitude of any comparative cost difference.

d. The cost calculations are expressed in current 1978 dollars. The uncertainty associated with the mid-term implementation strategy, as well as the requirement for comparative results, made the added complexity of price level and discount factors unjustifiable.

e. The cost analysis presented in this appendix assumes a typical 1988 network configuration for each alternative architecture for the purpose of computing nominal costs. Based on these mid-term configurations, a projected

network element inventory was developed. This inventory took into account both geographic and survivability considerations in order to determine the probable minimum number of each type of element required for each alternative. Typical CONUS and overseas configurations for the 1988 alternatives, as well as the expected 1983 baseline, are presented in Table 15.

B. Comparison Among Alternative Mid-Term Architectures.

1. Transmission Cost. Following the approach outlined above, comparative transmission costs for the three alternatives were computed. This involved sizing and costing various links in the network, using the backbone and access area topologies specified in the traffic model.

a. Assumption Guidelines. The following assumptions and guidelines were used in analyzing transmission costs:

(1) Link traffic estimates were used in sizing communication lines. The analysis was limited to narrative/record (N/R) and bulk data transfer (BDT) traffic. Estimates of interactive and query/response (Q/R) requirements show these to represent a relatively minor contribution to total AUTODIN traffic (less than 5%). Narrative/record estimates were furnished by the traffic analysis computer model, which takes into account the various subscriber types, their distribution, connectivity and service requirements. Estimated BDTs were computed in a similar manner. This traffic consists of terminal-to-computer and computer-to-computer transfers, and requires no services from a CSF or I-S/A AMPE(E).

(2) Consistent with the comparative character of the analysis, those links carrying the same traffic in all three alternatives were neglected. For the remaining links, however, the total traffic (architecture dependent and independent components) are used for sizing. This last category includes PSN-to-PSN and PSN-to-CSF links in the backbone, as well as I-S/A AMPE(E)-to-PSN and I-S/A AMPE-to-PSN links in the access area.

(3) Cost calculations were based on estimates of 1988 average busy hour traffic, assuming 1988 link configurations.

(4) Transmission facility lease costs were calculated based on available common carrier bulk tariffs

TABLE 15

TYPICAL CONFIGURATIONS

	BASELINE (1983)	PROJECTED BASELINE (1988)	ARCHITECTURE I (1988)	ARCHITECTURE II (1988)	ARCHITECTURE III (1988)
CONUS	8 PSN 4 ASC (COLOCATED WITH PSNs) 84 AMPE	8 PSN 4 ASC (COLOCATED WITH PSNs) 82 AMPE (REPLACEMENT) 21 AMPE (ORIGINAL)	8 PSN 4 CSF 58 I-S/A AMPE 21 AMPE (ORIGINAL)	8 PSN 8 I-S/A AMPE(E) 50 I-S/A AMPE 21 AMPE (ORIGINAL)	8 PSN 4 CSF 8 I-S/A AMPE(E) 50 I-S/A AMPE 21 AMPE (ORIGINAL)
OVERSEAS	3 PSN 7 ASC (2 COLOCATED WITH PSNs) 25 AMPE	3 PSN 7 ASC (2 COLOCATED WITH PSNs) 25 AMPE (REPLACEMENT) 10 AMPE (ORIGINAL)	3 PSN 2 CSF 20 I-S/A AMPE 10 AMPE (ORIGINAL)	3 PSN 7 I-S/A AMPE(E) 13 I-S/A AMPE 10 AMPE (ORIGINAL)	3 PSN 2 CSF 4 I-S/A AMPE(E) 16 I-S/A AMPE 10 AMPE (ORIGINAL)

for both voice-grade and wideband circuits. Rates (in current dollars) include mileage dependent and service (fixed) charges as follows:

(a) 56 Kbps trunks in the backbone ($6.72/mi/mo, $920/mo).

(b) 300-9600 baud lines in the access area ($0.56/mi/mo, $86.60/mo). Source: Defense Commercial Communications Office. NOTE: All lines are full-duplex, with capacity determined by the largest of the two unidirectional flows.

(5) For simplicity, modem and multiplexer costs were assumed to be architecture independent, and were excluded from the calculations. In addition, no attempt was made to optimize circuit selection by mixing available offerings (the impact would be to lower costs farily evenly).

(6) A nominal link utilization factor of 50% was used in this study, to account for overhead, traffic growth, and delay performance requirements. The effect of varying this value is discussed later, as a sensitivity issue.

(7) All elements were assumed to be single-homed for simplicity. The impact of dual homing on transmission cost is addressed later.

(8) The transmission cost study is restricted to CONUS configurations. However, it is likely that overseas alternatives will either be very similar (i.e., architecture independent), or implemented according to the corresponding CONUS strategy, in which case the same comparative results (ranking) should hold.

b. Summary. There is no significant variation in transmission cost among the three alternatives. As would be expected, Architecture I shows a slightly greater cost than the other two alternatives. This stems from the fact that all traffic requiring services must access a backbone-homed CSF. On the other hand, Alternatives II and III offer some or all of these services closer to the subscriber, in access area elements. In any event, the variation in total cost is no greater than about 6%. If costs common to all three architectures were included, this variation would be further reduced.

The number of service elements and the connection strategy for I-S/A AMPEs were chosen as architectural variables, while

TABLE 16

TRANMISSION COST SENSITIVITY ANALYSIS

ARCHITECTURAL PARAMETER	NOMINAL VALUE	IMPACT OF CHANGE
NUMBER OF PSNs	8 (CONUS)	• A FUNCTION OF THE NUMBER OF PSNs IN ALL THREE ALTERNATIVES • NO IMPACT ON COST RANKING
LINE UTILIZATION FACTOR (U)	50%	• NEAR LINEAR COST SCALING • NO IMPACT ON COST RANKING
FRACTION OF TRAFFIC DESTINED FOR LOCAL SUBSCRIBERS (I.E., REMAINING IN THE ACCESS AREA)	25%	• CHANGE IN RATIO OF BACKBONE TO ACCESS AREA TRAFFIC • NO MAJOR EFFECT ON RELATIVE COST RANKING
FRACTION OF I - S/A AMPEs CONNECTED DIRECTLY TO PSNs	30% 70%	AS THIS FRACTION INCREASES THE DISTINCTION BETWEEN ALTERNATIVES I AND II BECOMES BLURRED
LOCATION OF CSFs (SINGLE HOMING ASSUMED)	AVERAGE PSN - TO - CSF DISTANCE OF 50 MILES	• PSN - CSF TRANSMISSION COST IS PROPORTIONAL TO DISTANCE • ARCHITECTURE I DISPLAYS GREATEST IMPACT
LOCATION OF I - S/A AMPE(E)s (SINGLE HOMING ASSUMED)	AVERAGE PSN - TO - I - S/A AMPE(E) DISTANCE OF 200 MILES	COLOCATION WITH PSN SLIGHTLY REDUCES ACCESS AREA COSTS FOR ALTERNATIVES II AND III (REDUCTION IS SOMEWHAT GREATER FOR ARCHITECTURE II)
NUMBER OF SUBSCRIBERS AND/OR TRAFFIC VOLUME	AS SPECIFIED	• LINEAR COST SCALING • NO IMPACT ON RELATIVE COST RANKING
HOMING	ALL ELEMENTS SINGLE HOMED	• DUAL HOMING OF CSFs AND I S/A AMPEs CAN CAUSE A 5 - 15% INCREASE IN TRANSMISSION COSTS • INCREASE IS SOMEWHAT GREATER FOR ARCHITECTURE I

holding other parameters constant. In order to assess the impact of several of the assumptions discussed earlier, the sensitivity of the results to changes in these parameters was investigated. The parameters were varied over a reasonable range of values so as to identify trends in the behavior of the cost results. The findings are summarized in Table 16. As indicated in the table, variations in most parameters tend to affect all three architectures fairly equally, thus producing no significant effect on the comparative evaluation. Although the cost comparison applies to 1988 configurations, with similar topologies and comparable 1984-1988 transition plans, the evaluation results can be expected to hold throughout the mid-term.

In view of these considerations, transmission cost does not represent a driving factor in the selection of a preferred architecture. The cost variations obtained are of the same order of magnitude as the error associated with many of the underlying assumptions. Thus, no alternative can be singled out as best and the three architectures have been ranked equally.

2. <u>Nodal Element Acquisition Cost</u>. The comparative evaluation of potential acquisition costs for the alternative mid-term architectures relied on the following assumptions and guidelines:

a. Assumptions/Guidelines.

(1) The estimation of acquisition costs focused on nodal element hardware costs, as well as basic operating system software costs. A software-first development approach was assumed for applications software (which supports AUTODIN functions and services), using transportable software modules designed to run on all of the alternative hardware configurations. Since all three architectures must provide the same functions and services, applications software development costs were regarded as architecture independent and excluded from the analysis.

(2) Security functions (e.g., access control, key distribution) and multilevel security are to be provided through separate subsystems. As mentioned earlier, these issues were addressed under technical rather than cost criteria (see Appendix 4). In any event, it is expected that the implementation cost will be fairly uniform for the three alternatives.

(3) The militarization of nodal element hardware (I-S/A AMPE and I-S/A AMPE(E)) is to be accomplished under the I-S/A AMPE program, and thus has been excluded from the analysis. The militarization of I-S/A AMPE(E)s should entail no additional cost.

(4) Although some nodal elements may be leased, the cost estimating approach made use of one-time acquisition costs for convenience. In situations requiring an annual cost figure, the one-time cost was distributed uniformly over a ten year economic lifetime.

(5) In the specification of nodal hardware configurations maximum commonality and modularity were assumed. Furthermore, the nodal elements were based on a multiprocessor architecture.

(6) Cost estimates for network elements were based on commercial hardware suitable for a fixed plant environment, and do not include the cost of spare parts, documentation or other support costs.

(7) Acquisition cost figures are expressed in 1978 dollars.

b. Approach. In accordance with the preceding ground rules, acquisition costs of all major network elements were estimated using the approach described below.

(1) Representative hardware configurations were defined for the nodal elements of each alternative architecture (PSNs were assumed architecture independent, and excluded from the analysis). These configurations are required to support communications processing, service processing, and control processing. Each element was defined in terms of a standard set of hardware components (e.g., processor, memory, peripherals) selected from typical state-of-the-art communications processing systems.

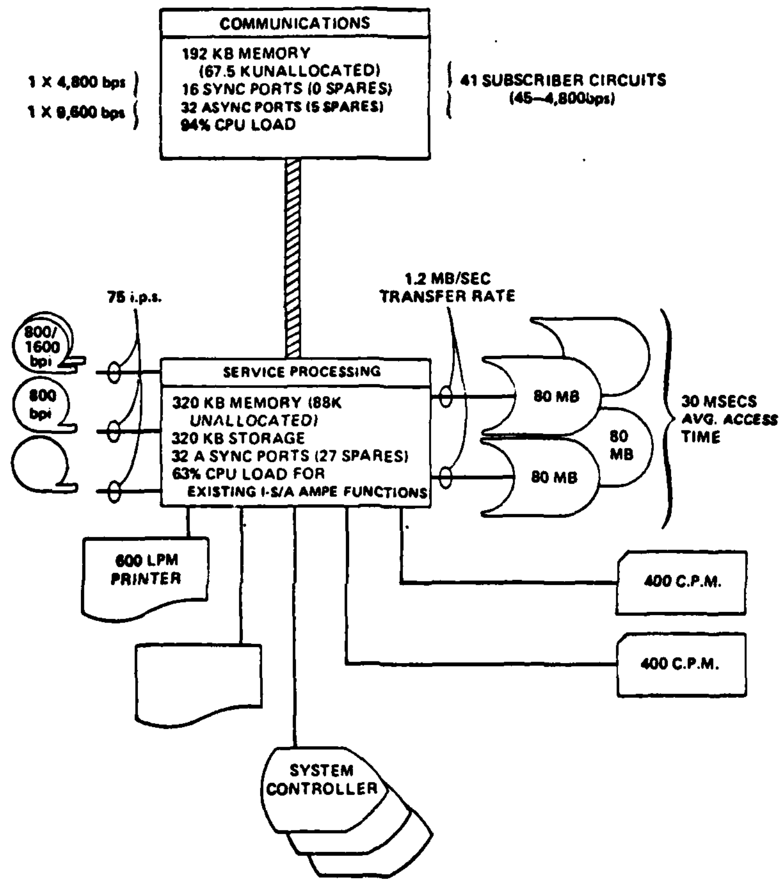
(2) The network elements were sized, using the set of standard components, based on the following inputs: functional capabilities required to support services allocated to the nodal elements; projected nodal throughput requirements provided by the automated traffic model; and the typical subscriber circuit and network trunk inventories (classified according to transmission speed and link protocol), derived from available AUTODIN projections. These inputs were used

to determine the requirements for processing power, memory and peripherals, as well as the operating system to manage them. Network element costs were then computed, based on hardware component cost estimates collected through vendor surveys and available literature. Finally, the total nodal element acquisition cost was compiled for each alternative mid-term architecture, using the typical network configurations of Table 15.

(3) The Tymshare Engine, a commercial processor, was selected as the basic building block in defining nodal element configurations. This unit, used as a nodal processor in a value-added network (Tymnet), was chosen for several reasons: (1) the Engine was specifically designed for communications processing; (2) it is suitable for a multiprocessor nodal architecture, and is fairly modular in structure; (3) it evolved from the Interdata 7/32, a well-known minicomputer. Furthermore, it is similar to the AF AMPE, which is also based on the 7/32; it is software compatible with the 7/32, and is supported by the same peripherals; and it is a more powerful enhanced version of the 7/32; (4) the Engine is representative of state-of-the-art technology.

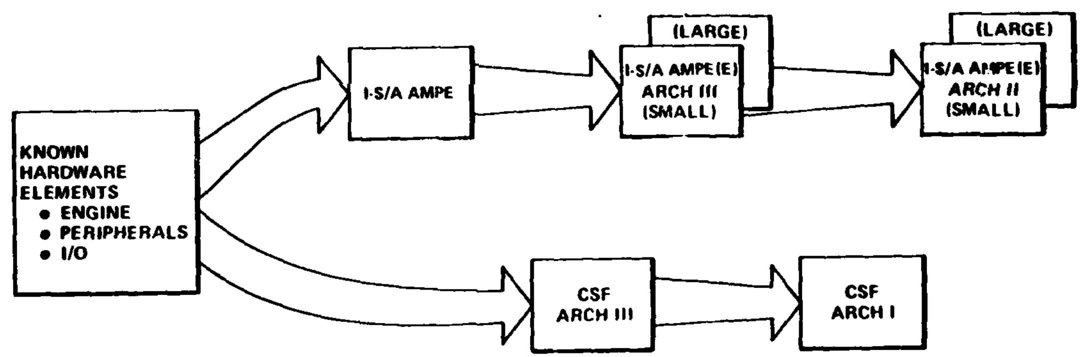
The Engine should be viewed as a "strawman" hardware implementation useful in a comparative analysis, rather than a nodal architecture recommendation. The nodal element hardware sizing procedure is illustrated in Figure 28, for the case of an I-S/A AMPE (common to all three architectures). The configuration includes two Engine processors, one for communications processing and one for service processing (with control functions present in both), as well as the necessary peripherals, storage devices and I/O parts.

To avoid redundant effort, the specification of hardware configurations was performed on network elements in order of increasing capability. In this way, the structure of one element could build on the hardware configuration of a less powerful element (which supports a subset of the functions and services of the first one) by adding extra components and capabilities. The results of the nodal element acquisition cost analysis are shown in Figure 29. The diagram also depicts the order in which these elements were configured, starting from a set of standard components. The cost of an I-S/A AMPE was calculated in spite of its architecture independence, since it represents an intermediate step in the definition of an I-S/A AMPE(E). The "large" and "small" versions of the



REPRESENTATIVE NODAL ELEMENT SIZING APPROACH (I-S/A AMPE)

FIGURE 28



NODAL ELEMENT ACQUISITION COST RESULTS (COSTS DELETED)

FIGURE 29

I-S/A AMPE(E)s result from different assumed I-S/A AMPE(E) populations. The smaller, more pervasive type is assumed in the typical configurations presented in Table 15 used throughout this study.

c. Summary. Based on typical 1988 network configurations and derived element acquisition costs, the overall acquisition cost for each alternative architecture was computed. The results are summarized in Table 17. Elements irrelevant to a comparative analysis have been excluded. It is evident from the results that total nodal element acquisition cost does not vary greatly among the alternatives. In addition, when the expected economic life of the elements is considered (about 10 years), the potential difference in annual lease cost is less significant.

Several observations should be made in the area of sensitivity. First, the simplifying assumption of uniform software development costs does not reflect the additional complexity and cost of developing and implementing software for more than one service element. Taking this into account would penalize Alternative III while making Alternative II more attractive. The likely effect would be to reverse the acquisition cost ranking presented in Table 17 showing a slight preference for Architecture II. The variation in cost, however, should still be relatively insignificant.

Finally, the assumption that would appear to have the greatest impact on the acquisition cost ranking is the number of network elements (i.e., the assumed 1988 configurations). However, because of performance and survivability constraints, no appreciable variation from the nominal values is anticipated. Furthermore, the cost advantage of a decrease in the population of a service element is partially offset by an increase in unit cost for the remaining elements, arising from additional throughput and service processing requirements.

3. Operation and Maintenance Cost. Of the major components of operation and maintenance (O & M) cost - personnel, spares and back-up equipment, facilities support (O & M installations), and utilities - personnel costs represent the largest contribution to total cost. In view of this, the analysis of operation and maintenance cost focuses on personnel requirements, and addresses the remaining factors in terms of the sensitivity of the results.

a. Assumptions/Guidelines. The assumptions used to calculate personnel costs for the candidate architectures are described below:

TABLE 17

PROJECTED NETWORK ELEMENT ACQUISITION COST

ARCHITECTURE ALTERNATIVE	NODAL ELEMENT INVENTORY	ESTIMATED COST PER ELEMENT	ESTIMATED SYSTEM ACQUISITION COST (1978 $)
I	6 CSF 78 I-S/A AMPE	CSF (DELETED) I-S/A AMPE	(DELETED)
II	63 I-S/A AMPE 15 I-S/A AMPE(E)	I-S/A AMPE (DELETED) I-S/A AMPE(E)	(DELETED)
III	6 CSF 66 I-S/A AMPE 12 I-S/A AMPE(E)	CSF (DELETED) I-S/A AMPE I-S/A AMPE(E)	(DELETED)

NOTES

1. EACH ELEMENT HAS BEEN DEFINED IN TERMS OF HARDWARE COMPONENTS SELECTED FROM TYPICAL STATE-OF-THE-ART COMMUNICATIONS PROCESSING SYSTEMS.

2. COST ESTIMATES REPRESENT PROJECTED ACQUISITION COSTS FOR NETWORK ELEMENTS BASED ON COMMERCIAL HARDWARE SUITABLE TO A FIXED PLANT ENVIRONMENT, AND DO NOT INCLUDE THE COST OF SPARE PARTS, DOCUMENTATION, OR OTHER SUPPORT COSTS.

3. COST ESTIMATES DO NOT INCLUDE AMORTIZATION OF HARDWARE OR SOFTWARE DEVELOPMENT COSTS.

4. ELEMENT INVENTORIES ARE BASED ON TYPICAL 1988 NETWORK CONFIGURATIONS.

(1) Projected manning requirements and annual pay rates (by personnel category) used throughout the operation and maintenance cost analysis are shown in Table 18. The table includes present ASC and AMPE levels for reference, as well as estimated levels for nodal elements used in the alternative mid-term architectures and the projected baseline.

(2) The estimates for ASC and AMPE personnel were obtained from available data on existing operations. In particular, personnel requirements for the ASCs are based on a Joint Service Human Resources Staffing Standard and Guide for ASCs, dated 1 Nov 1978. They include some indirect personnel, primarily in the areas of facilities O & M and hardware maintenance. Some categories have been aggregated for simplicity (e.g., Hardware Maintenance includes Computer, DSTE, Teletypewriter and Modem Maintenance). The standard personnel categories used are indicated in Table 18. Estimates for AMPE personnel requirements were based on proposed manning levels identified in Service provided AMPE plans. In order to ensure a meaningful comparison among network elements, the personnel categories were assigned comparable categories developed for the ASC. (These categories are estimated by extrapolation from available data collected in the AMPE studies and provided in the IASA Report (Part 1), Appendix 2.) Finally, the requirements for each category were adjusted to account for variations in AMPE types and sizes (the values in Table 18 represent overall averages).

(3) The manning estimates for new IAS elements were obtained using the available ASC and AMPE information as a baseline. These figures were then projected and adjusted for each element in question, with consideration given to element throughput requirements, anticipated processing capabilities, communication line and trunk terminating requirements and advances in technology.

(4) The following additional assumptions and guidelines were used in preparing Table 18.

(a) The Hardware Maintenance category has been included for comparative purposes, to illustrate the potential savings offered by the new IAS elements (maintenance is provided by contractors in all CONUS and many overseas elements).

(b) The manning levels shown in the table include more than the operations personnel but are restricted to personnel whose primary responsibility centers around the proper functioning of the network element.

TABLE 18

1988 PERSONNEL REQUIREMENTS ESTIMATES *

PERSONNEL CATEGORY	ASC 1978 LEVELS	ASC 1988 LEVELS	AMPE 1978 LEVELS	AMPE 1988 LEVELS (ORIGINAL)	AMPE 1988 LEVELS (REPLACEMENT)	FORMER AMPE (AFTER REVERTING TO MESSAGE CENTER STATUS)	I-S/A AMPE	I-S/A AMPE (E) (ARCH III)	I-S/A AMPE (E) (ARCH II)	CSF (ARCH. III)	CSF (ARCH. II)	PSN
OFFICER IN CHARGE @ $37,100	1	1	1	1	1	–	1	1	1	1	1	1
MANAGEMENT & ADMINISTRATION @ $21,200	10	10	5	5	5	1	6	7	7	5	5	4
COMPUTER OPERATORS @ $19,000 / OPERATIONS @ $18,200	29	29	40	40	40	19	40	42	44	20	28	20
TECH CONTROL @ $18,300	18	18										
SYSTEMS & SOFTWARE (ON SITE PROGRAMMERS ...) @ $27,000	3	3	2	2	2	–	2	2	2	2	2	2
COMSEC MAINTENANCE (CRYPTO) @ $18,600	19	14	8	7	7	4	7	7	7	3	3	10
(OTHER) HARDWARE MAINTENANCE @ $18,600	20	16	20	20	16	4	16	16	18	12	16	20
FACILITIES OPERATIONS & MAINTENANCE @ $17,300	6	6	3	3	3	2	3	6	6	3	6	6
TOTAL PERSONNEL	106	97	79	78	74	30	75	81	85	46	61	63
Total Cost ($K/YR) 1978 Dollars	2062	1895	1536	1517	1443	571	1464	1577	1653	953	1170	1222

* See Table notes next page

TABLE 18

Notes

1. "ASC 1988 Levels" represent reduced O&M personnel requirements that will result from introduction of new technology replacement subsystem during 1978-1988 period (e.g., second generation crypto equipments).

2. "AMPE 1988 Levels (Original)" represents O&M personnel requirements for AMPEs which have been deployed during the 1970s and remain in operation throughout the mid-term. The only personnel reduction relative to present levels arises in the area of crypto maintenance, as a result of the introduction of second generation equipment.

3. "AMPE 1988 Levels (Replacement)" represent O&M personnel requirements for AMPEs which are planned for deployment during the near-term to replace current AMPEs. These replacement AMPEs show a reduction in hardware maintenance requirements as a result of a certain degree of standardization and technological innovation in many of the subsystems.

4. Manning levels include only those personnel whose primary responsibility centers around the proper functioning of the network elements.

5. The Hardware Maintenance category has been included for comparative purposes (in many instances this service is provided by contractor).

6. The Facilities Operations & Maintenance category includes power production, air conditioning maintenance, etc.

7. The personnel requirements represent site totals, assuming four shifts.

8. Manning levels are for ASCs and AMPE 1978 levels are assumed to be averaged over the total population of an element (both CONUS and Overseas).

9. Yearly costs are weighted averages of the ASC personnel breakdown under each major category. The appropriate rates are taken from the DCA Cost and Planning Factors Manual (DCAC 600-60-1), and include base pay plus costs for retirement, training, recruiting and other support costs. Costs are in 1978 dollars.

(c) The personnel requirements represent site totals, assuming four shifts.

(d) Manning levels are assumed to be averaged over the total population of an element (both CONUS and Overseas).

(e) Yearly costs were weighted averages of the ASC personnel breakdown under each major category.

b. Summary. As a result of the above, system personnel requirements and total annual costs were computed for the alternative architectures (Table 19). As indicated in this table, Alternative II, when compared with Alternatives I and III, represents an additional savings of about 200 personnel, which would result in an additional estimated annual O & M cost reduction of about $4 million. Although the remaining components of operation and maintenance costs were not calculated in this analysis, it can be expected that consideration of additional O & M factors would increase the cost advantage of Architecture II over the other alternatives. Thus, the various types of nodal elements require similar installations, and hence the total cost of these additional factors tends to be primarily a function of the number of elements favoring the alternative with the smallest element inventory. No significant variation in the assumed 1988 element inventories is anticipated.

In view of these considerations, Alternative II is preferred. This conclusion should hold throughout the mid-term, assuming comparable implementation plans for the three candidates.

4. Cost Comparison Summary. In order to obtain a meaningful overall ranking of the alternatives based on their cost performance, the relative weight of each cost category should be considered. Although the comparative cost analysis specifically avoided calculating costs common to all alternatives, sufficient information is available to permit first order estimates of the total system costs.

a. Transmission Costs - the comparative analysis yielded an annual cost of about $6 million ($500K/mo) for CONUS. Inclusion of the architecture independent portion of access area costs, and extension of the analysis to overseas, produces a figure of approximately $20 million per year.

TABLE 19

PROJECTED O&M PERSONNEL COST

ARCHITECTURE ALTERNATIVE	NODAL ELEMENT INVENTORY	PERSONNEL REQUIRED	ESTIMATED ANNUAL O&M PERSONNEL COST (1978 $K PER YEAR)
I	11 PSN	693	13,442
	6 CSF	372	7,020
	78 I-S/A AMPE	+ 5,850	+ 114,192
		6,915	134,654
II	11 PSN	693	13,442
	15 I-S/A AMPE (E)	1,275	24,795
	63 I-S/A AMPE	+ 4,725	+ 92,232
		6,693	130,469
III	11 PSN	693	13,442
	6 CSF	288	5,718
	12 I-S/A AMPE (E)	972	18,924
	66 I-S/A AMPE	+ 4,950	+ 96,624
		6,903	134,708

NOTES:

1. NODAL ELEMENT INVENTORIES ARE BASED ON TYPICAL 1988 NETWORK CONFIGURATIONS.
2. PERSONNEL REQUIREMENTS REPRESENT SITE TOTALS, ASSUMING FOUR SHIFTS.
3. PERSONNEL RATES ARE BASED ON AVERAGE YEARLY COSTS.

b. Nodal Element Acquisition Costs - the comparative analysis showed an annual cost of approximately (DELETED) The addition of costs common to the three alternatives (such as software development, installation, etc.) is expected to double this figure. Amortization over a 10 year economic life yields an estimated annual cost of (DELETED)

c. Operation and Maintenance Costs - the analysis of personnel costs was quite comprehensive, and led to an annual figure of about $130 million. Additional O&M costs for utilities, facilities support, and spares, suggest a total annual cost of approximately (DELETED).

C. Comparison of Preferred Mid-Term Architecture to Projected Baseline.

1. The Projected Baseline.

a. Purpose. The purpose of this section is to gain insight into the potential advantage of implementing the preferred (Alternative II), mid-term IAS architecture. The comparative cost analysis was expanded to include comparison of the preferred architecture with the 1983 baseline architecture projected to a probable 1988 configuration (presented in Table 15). The projected baseline architecture would incorporate only those changes and upgrades required to maintain current system capabilities. The *projected baseline*, when compared with the preferred alternative architecture, provides an indication of the impact that will result if little or no action is taken toward the evolution of the AUTODIN system. In addition, this comparison emphasizes the potential cost savings of the preferred architecture.

b. Assumptions/Guidelines. The projected 1983 baseline architecture is based on the following assumptions: (1) ASCs retained in operation with minimum essential hardware/software subsystem replacement; and (2) AMPEs retained in all current locations and replaced at the end of their useful service life with a "standardized" AMPE. Based on current DoD policy, the projected baseline architecture includes provision for replacement of existing AMPEs with some form of standardized AMPE. However, because these equipments would not have additional capability of the I-S/A AMPE used in the preferred architecture, it is unrealistic to assume that consolidation could be achieved

in the projected 1983 baseline architecture. Therefore, the number of AMPEs projected for the 1988 configuration was derived from current and planned AMPE requirements (see Appendix 2). The comparison between the preferred architecture and the projected baseline centers on major cost elements, but extends some categories to include common factors (such as PSN and AMPE costs).

2. Transmission Cost. The comparative analysis of transmission cost determined relative little cost sensitivity to the architectural configuration or the basic underlying assumptions. Furthermore, the projected baseline must provide the same geographical coverage, and meet the same performance requirements as the preferred mid-term architecture. Therefore, no significant difference in link configurations is anticipated. The preferred architecture may yield, however, some cost savings, arising from the more effective use of traffic concentration and nodal processing.

3. Nodal Element Acquisition Cost. A comparison of projected network element acquisition cost for the preferred architecture versus the projected baseline was performed, using the same basic approach and assumptions outlined above. The results are summarized in Table 20. Only acquisitions unique to each architecture have been included (original AMPEs remaining in 1988 and PSNs are present in both alternatives). The cost of replacement AMPEs ("standardized") was estimated at 80% of the I-S/A AMPE cost. As a result, total estimated acquisition cost of the preferred architecture is approximately (DELETED) greater than that of the projected baseline. However, when total useful service life of the elements is considered, the cost impact is relatively insignificant.

4. Operation and Maintenance Cost. The comparison of operation and maintenance cost for the preferred architecture versus the projected baseline followed the same procedure and assumptions used to select the preferred alternative. The analysis focused, again, on personnel costs, and the comparative results are summarized in Table 21. As evidenced by this table, the preferred architecture offers a potential net savings of about 2000 personnel with a resultant net cost savings of about $39 million per year. It should be noted that the cost analysis takes into account that many

TABLE 20

NODAL ELEMENT ACQUISITION COST COMPARISON

	REQUIRED ACQUISITIONS*	ESTIMATED COST PER ELEMENT	(1978 $) SYSTEM COST
PREFERRED MID-TERM ARCHITECTURE (1988)	15 I-S/A AMPE (E)	(DELETED)	(DELETED)
	63 I-S/A AMPE	(DELETED)	(DELETED)
PROJECTED BASELINE (1988)	107 AMPE (REPLACEMENT)	(DELETED	(DELETED)

NOTES:

1. EACH ELEMENT HAS BEEN DEFINED IN TERMS OF HARDWARE COMPONENTS SELECTED FROM TYPICAL STATE-OF-THE-ART COMMUNICATIONS PROCESSING SYSTEMS.

2. COST ESTIMATES REPRESENT PROJECTED ACQUISITION COSTS FOR NETWORK ELEMENTS BASED ON COMMERCIAL HARDWARE SUITABLE TO A FIXED PLANT ENVIRONMENT, AND DO NOT INCLUDE THE COST OF SPARE PARTS, DOCUMENTATION, OR OTHER SUPPORT COSTS.

3. COST ESTIMATES DO NOT INCLUDE AMORTIZATION OF HARDWARE OR SOFTWARE DEVELOPMENT COSTS.

4. ELEMENT INVENTORIES ARE BASED ON TYPICAL 1988 NETWORK CONFIGURATIONS. (*See Table 15)

5. SUNK COSTS, INCLUDING PSNs, TERMINALS, ETC., HAVE BEEN EXCLUDED FROM THE COST COMPARISON.

6. THE AMPEs SHOWN IN THE PROJECTED BASELINE ELEMENT INVENTORY ARE STANDARDIZED AMPEs WHICH REPLACE CURRENT AMPEs DURING THE MID-TERM. (*See Table 15)

7. THE COST OF REPLACEMENT AMPEs WAS ESTIMATED AT 80% OF THE I-S/A AMPE COST.

TABLE 21

O&M PERSONNEL COST COMPARISON

1983 BASELINE EXTRAPOLATED TO 1988	TOTAL PERSONNEL	TOTAL COST ($K/YR)	PREFERRED MID-TERM ARCHITECTURE (II)	TOTAL PERSONNEL	TOTAL COST ($K/YR)
CONUS:			CONUS:		
8 PSN	504	9,776	8 PSN	504	9,776
4 ASC	388	7,580	8 I-S/A AMPE (E)	680	13,224
103 AMPE	7,725	148,629	50 I-S/A AMPE	3,750	73,200
	+	+	21 AMPE (CURRENT)	1,701	30,303
				+	+
	8,617	165,985		6,635	126,503
OVERSEAS:			OVERSEAS:		
3 PSN	189	3,666	3 PSN	189	3,666
7 ASC	644	13,265	7 I-S/A AMPE (E)	595	11,571
35 AMPE	2,835	50,505	13 I-S/A AMPE	975	19,032
	+	+	10 AMPE (CURRENT)	810	14,430
				+	+
	3,668	67,436		2,569	48,699
SAVINGS DUE TO COLOCATION OF PSN'S WITH ASC'S (4 IN CONUS, 3 OVERSEAS)	- 140	- 2,786	MANNING REQUIREMENTS FOR 29 AMPES WHICH REVERT TO LOCAL TERMINAL/MESSAGE CENTER STATUS AS A RESULT OF CONSOLIDATION	+ 870	+ 16,559
	12,145	230,635		10,074	191,761
NET SAVINGS ACHIEVED BY PREFERRED ARCHITECTURE				2,071	38,874

NOTES:
1. PERSONNEL LEVELS AND RATES ARE THOSE LISTED IN TABLE 18
2. COST CALCULATIONS ARE BASED ON TYPICAL 1988 NETWORK CONFIGURATIONS.
3. THE PROJECTED BASELINE INCLUDES CURRENT AMPES WHICH WILL BE IN SERVICE THROUGH 1988 AS WELL AS STANDARDIZED AMPES WHICH REPLACE CURRENT AMPES DURING THE MID-TERM.
4. PERSONNEL OVERHEAD COSTS FOR MANAGEMENT, LOGISTICS SUPPORT, TRAINING AND SOFTWARE DEVELOPMENT/MAINTENANCE ARE NOT INCLUDED IN ABOVE FIGURES

of the existing and planned AMPE sites eliminated through consolidation will revert to local terminal/message center operation. As a result, some of the O&M personnel formerly required at the AMPE sites will be retained for operation of the terminal/message centers (see Table 18). The magnitude of the potential savings indicated by this analysis demonstrates an opportunity for reduction of total AUTODIN system operation and maintenance cost through implementation of the preferred (Alternative II), mid-term IAS architecture.